NEW SCIENTIST

6 February 1964

Lasers: the widening spectrum

DAVID FISHLOCK

Aviation in 1984

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Duplication in research

JOHN MARTYN, *Aslib Research Unit*

Life in an ancient desert

Dr V. F. M. FITZSIMONS, *Transvaal Museum, Pretoria*

The new looms

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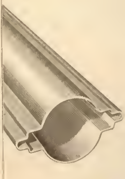

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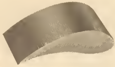

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John Player and Sons: Guide for the New Pipeman

Filling your pipe

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Notes and Comments

Long, hard road to the Moon

WITH the failure of the latest *Ronger* Moon shot this week to send back the expected close-up pictures of the Moon, many people will be sharing the American scientists' disappointment—which is the sharper since the most difficult tasks involved in getting the spacecraft on the right course and properly lined up to take photographs had been successfully accomplished. However, after the previous *Pioneer* and *Ronger* failures there must also be growing uncertainty about the programme of landing a man on the Moon by the end of the present decade. If it is to meet this target in spite of the trimming of its budget, the National Aeronautics and Space Administration cannot afford to waste any more of these ventures in terms either of the hard cash involved, or of time.

Before it is possible to confirm the design of the manned lunar landing craft, space engineers must know what conditions are like on the Moon's surface; is it made of thick dust or hard lava; if the latter, is it smooth, rubbly, or what? The *Ronger* programme, for which a further three launches are scheduled, is the first stage in the investigation of these problems. If the relatively simple experiments which it is intended to carry out cannot be performed with any degree of confidence, will there be enough justification for continuing with the much more ambitious and even costlier *Surveyor, Prospector* and *Lunor Orbiter*?

The weak point in the complex series of operations necessary firstly to get a spacecraft to the Moon with its solar cells properly aligned on the Sun for power, and its aerial correctly pointing back to the Earth to send and receive signals, and finally to start up its experiments, seems to lie in the fallibility of electronic components operating under extreme conditions. *Ronger III*, the first to attempt a rough-landing on the Moon, certainly started out badly—it was given too much boost on launching and crossed the Moon's orbit too soon—but a late decision to photograph the Moon in passing was defeated by a malfunction in the so-called central computer and sequencer (CC&S). Similarly, *Ronger IV* broke down shortly after being placed on its correct lunar trajectory due to a fault here; it crashed unproductively on the far side of the Moon. *Ronger V* succumbed early in its mission because of a circuit failure connected with the power supply.

Clearly NASA's engineers are conscious of this weakness for, since the previous attempt at a Moon shot in October 1962, they have been busy carrying out an exhaustive review of all *Ronger's* systems. They had introduced many changes to increase reliability, including such things as better electronic components, circuitry redesign and the provision of back-up systems to initiate the appropriate commands to the spacecraft in the event of either the CC&S or the Earth-signal receiver breaking down. In fact, the CC&S command to warm up the television cameras—one suggested seat of Sunday's trouble—was supported by radioed command from the Earth. NASA had also relaxed the sterilisation requirements for *Ronger*.

If, in spite of these careful modifications, *Ranger* continues to fail, critics will be entitled to ask if our technology is yet adequate for lunar exploration. Yet, the American rocket men, generally thought to have the most exacting task, are coping with their schedule remarkably well, as evidenced by the recent two-stage firing of the giant Saturn launcher.

Cancer patient acts as kidney-liver machine

TWO new techniques—one American, the other Japanese—give promise of saving the lives of some victims of liver failure. Many vital biochemical reactions take place in the liver and when disease reduces the functioning of the liver below a certain critical level of efficiency a vicious cycle of events sets in. The liver failure produces circumstances which further depress liver function and death is a common sequel. However, the liver has remarkable powers of regeneration, so that if a patient in liver failure could be helped over the critical period, a complete recovery becomes possible. Until now no treatment of the critical period has been particularly effective.

Dr James Burnell and eight coworkers at the University of Washington School of Medicine in Seattle have reported the use of a cross-circulation technique in the treatment of a 21-year-old woman who went into liver failure following the stillbirth of twins. She did not respond to vigorous orthodox treatment and was unconscious and showing classical signs of a rapidly approaching death when Dr Burnell and his colleagues decided upon a trial of their bold idea. They found a 40-year-old volunteer suffering from an incurable cancer but with healthy kidneys, liver and circulation. Using Silastic-Teflon tubes they connected an arm artery of the volunteer to an arm vein of the dying woman, and an artery of the woman to a vein of the man. This arrangement meant that the blood of both volunteer and patient intermingled and circulated through both bodies. It meant that the liver and kidneys of the volunteer could act for both bodies since they received and processed blood from both.

About 200 ml. of blood passed from body to body per minute and within

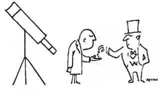
Notes and Comments *continued*

half-an-hour the woman showed a marked improvement and the kidneys of the man were excreting waste products which had been accumulating in the body of the woman. This cross-circulation was maintained for eleven hours, at the end of which time the woman was very much better. Nine hours after the procedure ended she again became critically ill and cross-circulation was reinstituted for a further 37 hours, after which the woman was conscious and in very fair condition. General improvement persisted for a further 16 days, but then the young woman died from a fatal haemorrhage. Although the effort finally failed, Dr Burnell and his colleagues had shown that their techniques made it possible for one person to lend the use of healthy organs to another in times of crisis.

The current issue of *Medical News* reports somewhat similar trials taking place in Japan. Dr Yukikho Nosé and co-workers at the University of Hokkaido have treated four patients in liver failure with a most ingenious modification of the artificial kidney machine. The artificial kidney takes blood from a patient, subjects it to dialysis, and puts it back. Dr Nosé puts freeze dried granules of dog liver into the blood-processing portion of an artificial kidney. The granules contain enzymes capable of doing some of the work which a normal liver inside the body does upon the blood passing through it. At the time at which Dr Nosé was interviewed, only four patients had been subjected to this treatment.

Two of them had a failure of liver function capable of surgical correction but were considered too ill to withstand surgery. After treatment on the machine many essential but disordered processes such as glucose metabolism and ammonia detoxification were so improved that it became possible to perform the necessary surgery and the patients survived. The other two with liver damage due to other causes improved with the treatment but died in the end.

These two techniques are very early but promising adventures into an extension of the highly successful and essentially simple artificial kidney routine. They suggest a whole new medical technology concerned with the temporary substitution of diseased but vital organs.



Baron bought his wife a place among the stars

WHEN Piazzi discovered the first minor planet, in 1801, it was natural for him to give it a mythological name; he selected Ceres. The practice was continued with the three asteroids discovered during the next few years (2 Pallas, 3 Juno, 4 Vesta) and when the discoveries began again, in 1845, No. 5 was named Astraea. However, the large numbers of asteroids detected after 1845 proved to be something of an embarrassment so far as names were concerned. Gods, demigods and mythological names lasted out for some time, but even in the early days there were a few departures from the general rule; 20 is named Massilia (Marseilles) and 25 Phocaea (after an Ionian town). Now that more than a thousand asteroids have been given permanent names, we find some very unexpected designations.

All the names have been explained, so far as is possible, by the noted Spanish astronomical historian, Professor A. Paluzie-Borrell, who has now issued a full list of them. The list makes fascinating reading. Students of mythology will appreciate 12 Victoria, 13 Egeria and 14 Irene, but what can one make of 1483 Hakoila or 1505 Korunna? Professor Paluzie explains that 1483 commemorates the Finnish physicist K. J. Hakoila, who acted as assistant to the asteroid's discoverer, Y. Väisälä, while Korunna is the name of a tribe of wandering Bushmen who inhabit the Kalahari Desert. The connection between bushmen and asteroids is not obvious, but this is not Professor Paluzie's fault! There are asteroids named after birds (714 Ulula and 709 Fringilla—Latin for owl and linnet respectively—to name only two); plants (1056 Azalea, 1091 Spireae, 1220 Crocus); cities and countries (1554 Yugoslavia, 397 Vienna, 460 Scania) and even societies (1626 Sadeya, initial letters of the Sociedad Astronómica de Espana y América). Asteroid 1625 is named The NORC, after the Naval Ordnance Research Calculator at Dahlgren, Virginia, which has been used to compute minor planet orbits.

There are many personalities, both fictional (such as 171 Ophelia) and historical (216 Cleopatra). Discoverers of asteroids have not been slow to honour their friends and relations; for instance Professor Kopff, a noted asteroid-hunter, named 526, 607 and 616 Schiela, Jenny and Elly after three of his friends. The contemporary astronomers Dr Harlow Shapley, of Harvard, and Dr Gerald Merton, of Oxford, are commemorated in 1123 Shapleya and 1299 Mertona; we also find 1462 Zamenhof (the inventor of the Esperanto artificial language) and 1058 Grubba (Sir Howard Grubb, the optical worker). In some cases the associates are not so obvious as they might seem; 1486 Marilyn refers to the daughter of Dr Paul Herget of Cincinnati Observatory, while 426 Hippo is in no way zoological, and is named after a city—probably Hippo Regius of Numidia. The Trojan asteroids, which move in the same orbit as Jupiter, have been given special names associated with the siege of Troy, and even in the higher numbers we still find occasional returns to mythology: 1184 Gaea, for instance. It is fortunate that the habit of renaming objects to keep abreast of political changes has not spread to the asteroid belt, as otherwise 830 Petropolitana (St Petersburg, Petrograd and now Leningrad) would have undergone several metamorphoses. Now and then one has the feeling that one is entering deep water; 1588 Descamisada is, according to Professor Paluzie, "literally a naked woman. As a symbol of the Argentine trade unions, it means a shirtless worker. Eva Peron adopted this symbol of the very poor people and was called The First Descamisada", while there is another tribute to Eva Peron in the name of asteroid 1589—though since the chosen name is Fanatica, it may not quite create the impression intended!

A few amusing anecdotes come out. For instance, when Palisa of Vienna discovered asteroid 250, he announced his willingness to sell the right of naming it, in order to raise funds for his eclipse expedition of 1886. Eventually Baron Albert von Rothschild named the asteroid after his wife, Bettina. When numbers 1127 and 1145 were discovered at Uccle Observatory (Belgium) by Arend and Deporte respectively, Arend chose the name of Robelmonte, after his native village, and Deporte chose his wife's name of Mimi, but owing to some curious confusion the two names were interchanged, so that 1127 is now Mimi and 1145 Rohelmonte. Finally, it is worth noting that the German astronomer G. Stracke (1887-1943) refused to allow his name to be given to an asteroid. After his death, K. Reinmuth discovered eight successive asteroids, numbers 1227 to 1234, and named them Geranium, Scabosia, Tilia, Riceia, Auricula, Cortusa, Kobresia and Elyna, so that Stracke's name is at least spelt out by minor planets!

According to R. S. Richardson, the total number of asteroids amounts to 44 000, while some Russian estimates are considerably higher still. If so, the ingenuity of name-givers is liable to be taxed even more severely in the future than it has been in the past.

Jet noise will get worse before it gets better

NOISE nuisance from jet engines in the neighbourhood of busy airports has been mitigated but not abated by regulating take-off procedures, by the wider use, for other reasons, of by-pass and fan types of engine and by the fittings of silencers to the jet nozzles. A pamphlet, *Quietening the Jet*, has just been published by the Minister of Aviation, giving details of the work done and the money spent in this cause and explaining what further work is in hand, who is doing it and how much public money is allocated to it in the current year.

It makes no lavish promises. It is, rather, an honest statement on a difficult proposition. It might be regarded as the "soft answer that turneth away wrath" or as an appeal not to "shoot the pianist; he is doing his best". The Ministry is indeed doing its best to hold a delicate balance between public interest, safe air operations and economic sanity. A level of perceived noise on the ground has been set. Methods of take-off and climb which will not exceed that limit have been prescribed and regular monitoring arranged. Money has been and is still being applied to research into noise suppression. Airlines have spent hundreds of thousands of pounds in silencing apparatus and are carrying continuous heavy costs in the form of reduced pay loads in consequence of the take-off rules.

All this has not led to a cure but it has served as a fairly successful palliative beyond which further improvement is going to be slight and slow. Unfortunately, in that period, the nuisance will increase in frequency. It is already beginning to change in kind. Hitherto the main trouble has come from the roar of the jet pipe at full-power take-offs; more complaints now are evoked by the whine of compressors during the approach. Over this there is at present no official control. The approach noise is likely to disturb many more people than the take-off noise because it persists over a glide path eight miles long, beginning at a height of 2000 ft and descending on a slope of about one in 20 to the runway.

Like the take-off nuisance, this annoyance is going to increase in frequency. This year there will be more than 200 movements of jet aircraft every day at London airport. By 1970 the number is estimated to rise to 440 a day. In the intervening years more powerful gas turbines will come into service with heavier noise levels. Little more can be done at present about silencing jet nozzles. Steeper climb-out cannot be demanded if a safety margin is to be left. Hope of maintaining present noise standards at take-off must depend on designing noise suppression factors into new engines and this is in fact being done in the Olympus engine destined for the Concord. A suggestion has been made for an agreement between Britain and the United States, the chief makers of jet engines, for concerted action in this respect.

Designing for silence is not an easy or simple process and may involve penalties—hence the idea of joint action among competing manufacturers—but it is not impossible within modest limits. On the subject of noise on the approach, a panel at Rolls-Royce has already made an analysis which located the source as being not only the first two stages of the axial compressor but also the turbine and exhaust. This also showed that part of the compressor whine—but not the whole—could be prevented by changing the number of the blades and their disposition. Complete cure appeared to depend on modifications aimed at a reduction of air-speed in relation to the blades or removal of the boundary layer at their trailing edges.

Work on approach noise is going to be as important as that on take-off noise. Approaches cannot be subjected to the same kind of control as climb-out, yet far more people on the ground will be affected by approach noise, especially at London airport where most take-offs towards the west pass over thinly populated areas and most approaches on the same line pass over built-up areas between Hammersmith and the airport. The Ministry's pamphlet shows that nearly £300 000 is being spent this year on engine design in the cause of noise reduction. No dramatic solution is promised but patient and intelligent work on the subject is pledged.

Compromise is the best that can be expected. No word is said by the Ministry about the risk of driving business away by too tight a control but those acquainted with the matter have noted that this has actually happened somewhat disastrously at Newark airport in New Jersey.

How mussel muscle can catch an oystercatcher

BY and large the birds of the world are aptly named in the sense that owls yowl, hoopoes call *hoopoe*, woodpeckers peck wood and even the oystercatcher catches an occasional oyster, although in Britain they seem much to prefer cockles and mussels to Whitstable natives. What has always been something of a puzzle to ornithologists and animal behaviourists is how these black and white, almost cosmopolitan waders manage to bash tight-clamped bivalves to bits, even with a dextrously used chisel-shaped bill. There have been several reports on this subject and at least one Chinese fable about what happens to the oystercatcher who gets caught. In the February issue of *British Birds*, Dr Niko Tinbergen and Mr M. Norton-Griffiths of the Zoological Department at Oxford have put forward some thoughtful observations of their own.

They were made on the Drigg Peninsula, a particularly birdy part of the Cumberland coast near the Ravenglass gullery, where a pair of oystercatchers conveniently made their nest on a relatively bare patch of sand surrounded by a luxurious growth of nettles and burdock. This meant that the pair and their chicks were somewhat restricted in movement and could be spied on through a hide.

Each day the parent birds spent high tide with their young and then flew off to the nearby estuaries to get food when the ebb began. The daily menu of the Drigg family was composed of a light *hors d'oeuvre* of marine worms and an occasional crab followed by a progressively more rapid supply of mussels as the tide went down and more and more molluscs were exposed.

On their arrival at the nest, some of the mussels had already been taken out of their shells and were fed whole to the young without further ado, but others had to be opened on the spot and a litter of shells showed that the oystercatchers were adept doing this. Although they had no means of pinning the mussels to the sand, the birds got at the juicy bits inside by chiselling away at the fibrous mantles with their bills and prizing the valves apart in much the same way as a starling or a rook prizes open matted vegetation. In shallow water the birds stealthily stalked partly-open mussels and cut through their adductor (valve-closing muscles) with a stabbing blow.

What happens to the bird that fails to strike home with its first shot is evident from the observations of another ornithologist, Mr Peter Bennett who found an oystercatcher near Southport with half an ounce of mussel securely clamped on to the end of its bill, making flight impossible and even running rather difficult. He caught it and pulled the mussel off whereupon the bird flew away. In the Chinese fable, an oystercatcher caught in the same way, says to the mussel: "If it does not rain today or tomorrow you will die." The mussel replies: "Yet if it does rain you

Notes and Comments *continued*

will die", but it happened that along came the inevitable hungry man and the two animals met again in his stomach.

The Drigg observations make it clear that oystercatchers have mastered several methods of dealing with bivalves and at least one of stabbing a crab to death by turning it over on its back and piercing the vital nerve aggregation called the supraoesophageal ganglia with the intrepidity of a matador. From the basic pecking movements of the young birds (one of them pecked at the observers' bare toes protruding from the bottom of the hide) it looks as if extremely diverse food-handling methods have been learnt or developed on the framework of simple innate habits. As Dr Tinbergen and his associate point out, in the oystercatcher there is an excellent subject for a study of the ontogeny or sequence of development of feeding behaviour.

Liberal leader in discussions about science

If the Liberals are the last of the British political parties to start treating science policy as a matter of great moment, they have the advantage of being able to begin by consulting scientists and industrialists who have thought out the implications of the Robbins and Trend reports. Last week, Mr Jo Grimond, the Liberal Party leader, discussed the role of government in research and its application with a distinguished group meeting in Westminster under the chairmanship of Sir John Cockcroft.

The party assembly in Brighton in September 1963 had passed a resolution urging a comprehensive policy for science and engineering; it emphasised the importance of university research and called for the establishment of "a real Ministry for Science". Since then, of course, the whole question of ministerial arrangements for science, higher education and industry has been thrown into the melting pot by the Conservative and Labour leaders and the idea is growing that a Minister "of" or "for" Science may not be necessary—at least in the long run. At last week's meeting, it was broadly agreed that the function of the Minister should be defined more closely.

Several speakers emphasised the need for flexibility and broad representation in the management of science. In particular, the scientific advisory body envisaged by Trend should, it was argued, be able to take political and economic factors into account when discussing expediture on major new research projects; cross-membership with the National Economic Development Council was one of the proposals.

As the two big parties consider radical new approaches to science, technology and education, and prepare to commit themselves to definite policies, they will have plenty of opportunity for making mistakes. A well-informed Liberal Party would be able to make useful criticisms and present another point of view, so it is to be hoped that Mr Jo Grimond is not thinking he has "done his duty" by science but is prepared to pursue the trains of thought suggested to him by the scientists last week.

Why do most accidents happen near airports?

An intensive examination of the behaviour and performance of air liners in the vicinity of London airport is to be undertaken this year in the interests of safety. More than half the accidents happen near airports. Why should this be and what can be done to improve the situation? Are the characteristics of the aircraft to blame? Are the aids—radio, radar and lighting equipment—adequate and properly operated? Do the varying regulations of different operators affect the matter? What risks arise from the take-off and climb requirements imposed to reduce noise nuisance on the ground? Are pilot handling techniques sound? Are weather minima reasonably set?

Those and other considerations associated with take-off, landing, approach and climb-out will be analysed by a highly-qualified technical group just set up by the Ministry of Aviation. The investigation will depend not only on observation and on the testimony of airport officials and pilots but also on photographic and radar evidence. It will be supplemented by the tapes of flight recorders already installed in a number of Comet and 707 liners. These are the electronic devices which record on tape continuously what is happening to the various parts of the aeroplane and its instruments and apparatus. The programme provides for at least 3000 aircraft movements to be studied.

For the purposes of this analysis, operations within a radius of 15 miles of the airport will be under scrutiny. Similar studies may be made, if the group should find it desirable, at other British airports. The plan is concerned with more than present circumstances. It looks forward to the imminent use of automatic flare-out (the closing of the throttles and setting the aircraft in the landing attitude just before the touchdown) which will come into use with the introduction of the VC 10 and the Trident to the air routes in April. It will discover whether or not existing equipment and methods will permit that advance towards blind landings to be taken with reasonable safety.

This is to be regarded as an investigation of the utmost importance. It should assemble a great body of expert evidence as to what happens in the critical few minutes when aircraft are near the ground. In theory, they are far better served with aids near an airport than they are en route. In theory, pilots are most alert, attentive and meticulous at take-off and landing. On the other hand, any mechanical or instrument failure, any misuse or careless use of apparatus in the aircraft or on the ground, can have disastrous consequences when the time margins for emergency action are so fine.

Last year was the safest yet in commercial air transport. Nevertheless, the incidence of accidents near airports was at least as high as ever. If the present inquiry can determine the dominant factor, steps can be taken to diminish this highest of all flying risks.

The "wise men" of UNCSAT chosen

The Economic and Social Council of United Nations has chosen the 18 members of the committee that is charged with continuing the work begun a year ago at the big UN conference in Geneva on the application of science and technology for the benefit of the less-developed area (UNCSAT—see special issue of *New Scientist*, 14 February 1963). The president of the conference, Professor M. S. Thacker of India, called for the creation of such a group of "wise men", but ECOSOC has taken a long time to follow it up and has not given the committee the broad brief for urgent action or the authority to cut through international red tape that might have been desired.

Professor Thacker himself (a member of the Indian Planning Commission) has been appointed and other Commonwealth members are Sir Norman Wright, Secretary of the British Association, Professor Abdus Salam, scientific adviser to the president of Pakistan, Sir Ronald Walker, Australian ambassador to France and Dr Eni Njoku, Vice-chancellor of the University of Lagos. Professor Pierre Auger, in charge of Europe's joint space research, Professor Carroll L. Wilson of the department of industrial management at the Massachusetts Institute of Technology, and Mr Abba Eban, Israeli Minister of Education, have also been appointed. The 11 other members come from many parts of the world.

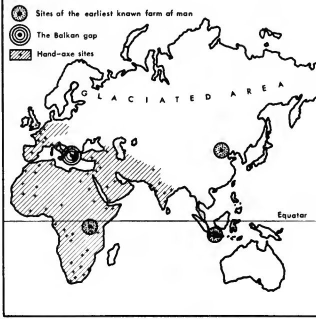
Did all Europeans come from Africa?

PALAEONTOLOGISTS are still arguing about the age of the remains of the extremely old man-like animals that have been dug out of the walls of the Olduvai Gorge in Tanganyika. They are almost certainly more than 800 000 years old and probably twice as old as the oldest comparable remains found many years ago in China and Java. It is, of course, quite possible that the ape-like ancestors of man lived in more than one part of the world and that the present human race is the product of parallel evolution. What is virtually undisputed is that Africa could have provided all the likely conditions for the emergence of ape-like men and the development of recognisable forms of men that rose from the hypothetical ancestral stock.

Africa possesses a rich primate fauna. Several species of relatively unspecialised apes seem to have been widely distributed at least as far back as the Miocene of 20 million years ago. In the Rift Valley there are almost boundless possibilities for evolution. Forests descend to the edge of the rivers and great lakes; the gamelands are remarkable for their variety and abundance of hooved animals, all of them potential sources of food; in the mountains, a unique spectrum of habitats is found one above the other, stratified like a Neapolitan ice. Africa, therefore, may be regarded as the most likely, if not the one and only cradle of mankind.

Palaeontologists have for long debated the routes man took when he left Africa and invaded Europe and the Middle East and when these early human migrations began. No one is likely to provide an outright answer to the second question. Early human fossils are exceptionally scarce and the earliest human invaders left behind no tools that can yet be closely dated, even by comparative methods. Hordes of human scavengers used pebbles or bits of crudely chipped rock which are usually indistinguishable from fragments ("eoliths") shattered by the weather or other natural forces.

The only widely-distributed tool that unmistakably marks the habitations of early man is the hand-axe, a two-faced, pear-shaped piece of workable rock, mostly flint, that has been found in many hundreds of sites from northwest Europe to South Africa. This is the Chelles-Acheulian axe named from two sites in northern France where large numbers were found before anyone knew how widespread they were. On the present evidence it looks as if the classic hand-axe tradition arose in Africa and the presence of the axes in Europe marks the course of a migration or series of migrations of early African populations. In other words, they are route markers.



Hand-axes have been found in various sites, from Britain to the tip of South Africa and east to India. One of the first stone tools on record was dug up in Gray's Inn Lane, London in 1690 by a pharmacist called Conyers. It was found in association with fossil elephant bones. Antiquarians thought it was a spear head used by "Ancient Britons" in their efforts to repulse the elephants in the Roman legions of Claudius. The first examples of the classic Acheulian and Abbevillian weapons from north France were described by Boucher de Perthes, a French customs official, in 1846.

The Chellians (or Acheulians) of about a quarter of a million years ago were almost certainly not as numerous as their discarded tools suggest. During their individual lives they probably made and discarded large numbers of axes on the palaeolithic equivalents of dumps or refuse heaps.

By linking up all the known sites in southern Europe and north Africa, Professor Chester S. Chard of the University of Wisconsin has speculated on how the axe-makers either crossed or skirted the great barrier of the Mediterranean. As he sees it, the migratory Africans could have crossed the Straits of Gibraltar or the strip of sea between north Africa or Sicily; alternatively they could have crossed the Bosphorus or worked their way around the eastern end of the Black Sea.

As Sicily was not occupied by man until upper palaeolithic times and, until recently, no remains of hand-axes had been found in the Balkans, Professor Chard concluded that early man crossed over into Spain at a time when the Straits were narrower than they are today, a suggestion borne out by relatively abundant remains on both sides of the channel. However, the Balkan gap has now been closed by the recent discovery of hand-axes in northern Greece made by Mr E. S. Higgs, of the Department of Archaeology and Anthropology at Cambridge.

Mr Higgs sought for evidence of the palaeolithic occupation of Greece because, although no early artefacts had been found there, he thought that the lowlands would have experienced a favourable climate during glacial periods and would have been suitable for migrations. He found the artefacts he was looking for and showed how all Europeans could be essentially African in origin.

Notes and Comments *continued*

The mechanical miner gets at the thin seams

EARLY in 1962, the National Coal Board started trying out a new machine for mining thin seams called the Collins Miner (see "Science in British Industry", 29 March 1962). Its surface trials were promising, so the machine was taken underground at the New Lount Colliery in the East Midlands Division and since then has been working away in a seam 2 ft 7 in. thick.

The machine cuts a slot into the seam about 6 or 7 ft wide and the coal is carried back from the cutting head on a conveyor belt which turns a right angle and bears the coal away down the roadway in which the control train of the miner runs. The cutting head is forced into the seam by push rods as it bites the coal out and the general idea is to cut one slot or "stall" to a maximum length of 100 yards, move the train on and cut the next, and so on. At the end of the roadway the train is turned round and the miner cuts stalls down the other side. In spite of some unforeseen difficulties at New Lount—for example, the machine ran into rock only 40 ft along on its very first stall and ruined the cutters—the results have been most encouraging for the NCB.

On its best day, the miner's output was 25 tons per man shift and over one week it averaged 16 tons per man shift. The usual output with machines is 3 tons but the miner has been consistently averaging 5 tons per man shift. Two more machines are soon to be working, one at the Fishburn Colliery in County Durham where it will be mining high quality coking coal and another at Rothwell Colliery in Yorkshire. In fact, the NCB is so pleased with the miner that it is thinking of both scaling it down and scaling it up to tackle different thicknesses of seam; scaling down implies more redesign, but there are few doubts that the miner can be made to cope with seams only 18 in. thick. As there are large reserves of coal in Britain in thin seams the potential is attractive.

The more important snags that have come up during the New Lount trials have been concerned with steering the miner in a vertical direction. One of them has been overcome simply enough by moving steering jacks from the back of the machine to the front to cut down steering movement. How much the machine has to move up and down to follow the coal seam has, up to now, been shown by a radioactive source underneath it. Back-scattering of gamma radiation is used to indicate to the operator the thickness of coal under the machine. In theory he can keep the ideal thickness of half an inch, but in practice small coal has been getting under the skids on which the machine moves and falsifying the measurement. On the new machine at Fishburn radioactive sources will be tried on the side instead of the bottom and on the top, where readings can be obtained from the roof which generally follows the same contour as the floor of a seam.

Incidentally, the NCB is using americium instead of the original thulium as the source on new machines. The element, a transuranic one with a half life of 475 years is bought from the Radiochemical Centre at Amersham. Americium is obtained from the decay of plutonium-241.

Science students face world bottle-neck

ON a world-wide basis science students probably have more difficulty than others in starting university studies but once in they are more likely to continue. That conclusion stems from a newly published UNESCO report *Access to Higher Education* Vol. I by Dr Frank Bowles (HMSO 15s.).

Thus in Germany there are complaints of a poor distribution of students among fields of studies and "because the need for manpower in the physical sciences and engineering field is especially urgent, this development corresponds neither to the vocational aspirations of the students nor the requirements of society".

In France competition appears to ensure that accepted science students are better prepared than others for further studies although for an established country, educationally speaking, student survival rates in all courses are relatively low. In Britain there is a partly effective safety valve for excessive numbers of science and engineering students in the shape of sandwich courses of various kinds but, as is well known, these are not always taken up.

The problems of student selection and wastage in Europe pale into insignificance when compared with those in Africa and Asia. In India, for example, it appears that science and technology are the first choice of the majority of students, whether qualified or not, and that other faculties find many of their recruits among the rejects of the science departments.

In Africa, the United Arab Republic tends to favour science students in the matter of grants. Throughout the rest of Africa, with the exception of South Africa, grants are widespread. In South Africa aid is limited and declining. Throughout Africa, with the exception of the UAR, there is a shortage of applicants and experience of African science students and other reports lead one to suppose that there is a very long tail of poorly qualified science students. This report deals in effect with the present world situation and reveals an overall picture of opportunity for science study in direct proportion to the degree of development. This implies, of course, an inverse ratio to need. This systematic analysis of the troubles may help—the solution to be faced is more money and more teachers.

Computers cut competitors' agony

ONE of the sights of winter sports is a row of fur-wrapped figures shuffling forward on to the ice of a skating rink and, on a whistled command, holding up cards giving scores for the last competitor's performance. A particular skater's position may be drastically changed by these stoic judges, but until recently it has taken a long time to discover their effect. When the Winter Olympics were last held in Europe—in 1956—the complete list of placings did not appear for eight hours, time enough for a nervous competitor to wear out his fingernails. Even this calculating time was achieved only by data processing methods. In Oslo, four years before, some Olympic athletes were on their way home without knowing who had won.

Things are ordered better at the Winter Olympics in Innsbruck, which are now in progress and continue until 9 February. An IBM computer system is in use which should improve on the time of that installed for the Winter Olympics of 1960 at Squaw Valley in the USA. Complete figure skating results then took twelve minutes to calculate. When the Innsbruck system was tested, it computed and printed out results for the Women's International Junior Skating Championships in two minutes. In speed-skating, rank can be displayed on the public scoreboard approximately 10 seconds after the times have been received.

For some months programmers have been setting up the two computers which sit at the centre of the system. The machines' memories have been filled with the rules for the events and information about the competitors and between them could cope with six different events at the same time. Times, points and so on are fed in by telephone line from the various events, processed and the results printed out.

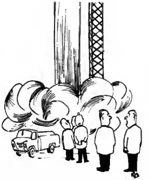
Skiing is handled in short order by the computers. Starting on his run, each competitor whips through a metal gate and records of the time down to tenths of a second. This time is then transmitted to the computer, some miles away. The machine first recognises the event, stores the time, sorts out the appropriate scoring instructions and sends back the original time as a check. The skier records his finishing time in the same way by passing through a gate and this, too, is sent on to the computer and checked back. Then the computer subtracts the start time from the finishing time, prints out the result and stores it ready to compare with the times of other competitors, the whole process taking less than two seconds. Simultaneously the computer is comparing times, sorting out the ten fastest racers and printing them out, keeping the scoreboards and public address systems up to date with the changing situation.

To complete the job it also produces a punched paper tape giving all the details on a particular competitor so that the information can be sent out via teletype printers. Apart from its obvious advantages for spectators, the system also acts as a spur to the athletes taking part. They know what they have to beat to stay in the running.

Move to reform US narcotic laws

An advisory commission appointed by the late President Kennedy has called for drastic changes in the many ways in which the United States handles the challenge of narcotic and drug abuse. In effect, the over-all therapy recommended in the 123-page report calls for massive doses of research, rehabilitation, and revision of enforcement laws and agencies. Where the Brain Report settled largely for inaction, the Commission recommends a considerable amount of action ranging from the appointment of a Special Presidential Assistant for Narcotic and Drug Abuse to strict control by federal statute for all non-narcotic drugs capable of producing serious psychotoxic effects when abused.

The most controversial of the recommendations are those which would virtually do away with the Federal Bureau of Narcotics by transferring its investigatory and regulatory functions from the Treasury Department to the Departments of Justice and Health, Education & Welfare, respectively. The Bureau has been the continuous target of private citizens' groups and federal judges who find its methods "heavy-handed". Nonetheless, it appears that the Bureau will survive this latest attempt to kill it. Spokesmen for both the Treasury and Justice departments have already opposed the suggestions.



"Good heavens, no! I thought you were putting the payload aboard."

Another major recommendation calls for the enactment of a federal civil commitment statute to provide "an alternative method" of handling the federally convicted offender. New York and California now have such laws aimed at giving selected violators a chance to rehabilitate and to have a criminal conviction erased from their records. Excluded from the proposed civil commitment programme would be people convicted of a crime involving smuggling or trafficking in narcotic drugs in large quantities or selling narcotic drugs for resale, or a crime of violence. Disagreeing with the Bureau of Narcotics' view that present severe penalties regarding narcotic drugs and marihuana constitute a powerful deterrent, the Commission also recommended that: "The penalty provisions of the Federal narcotics and marihuana laws which now prescribe mandatory minimum sentences and prohibit probation or parole be amended to fit the gravity of the particular offence so as to provide a greater incentive for rehabilitation."

The Commission also disagreed with what it termed "the British system" for maintaining the addict. The principal reason—the British addict appears sufficiently motivated to lead an ordinary life; "the American addict is quite different".

Throughout the report, the Commission stressed the inadequacy of information about the problem from the "great ignorance of the patterns of drug abuse", to the "pitifully inadequate" data about the numbers of American addicts. As one answer, it recommended that the Federal Council for Science and Technology develop a comprehensive national research plan. And, finally, among the Commission's recommendations is the proposal that legislation be enacted to authorise the use of wiretapping by federal officials to detect and prevent the international smuggling of narcotics.

The report, which is available for 55 cents from the US Government Printing Office, Washington, D.C. 20402, was released by the White House without comment, and is now being reviewed by various government agencies.

Variable-pitch fan for cars

Automobile engineers have recently been taking a close look at their cooling fans, which, if they provide adequate engine cooling under the worst operating conditions in hot weather, are absorbing power unnecessarily at other times. The simplest device yet seen for reducing this power wastage was introduced recently by Serck Radiator Services Ltd of London.

In the Serck fan, which retails for £5, each of four blades is pivoted to have a variable pitch. Drag of the blades reacts on a coil spring loaded in torsion, and when the drag is large enough to overcome pre-load of this spring, blade pitch is reduced. The device would normally be set to give normal fan action up to about half an engine's maximum operating speed, beyond which speed the increasing blade drag would result in partial feathering of the fan blades to an extent varying with the spring stiffness. It is suggested that, as the most critical condition for engine overheating is usually operation at a maximum-torque speed (which is around half an engine's top speed) it should be possible to set this variable-pitch fan to reduce power loss at maximum r.p.m. by from 50 per cent, to 65 per cent. Engine noise at high speeds will be reduced by this device, but it will not improve engine warming-up speed after starts from cold.

The more sophisticated devices already tried include three forms of fan control by temperature-sensing switches or thermostats. Several British cars are in production with electrically driven cooling fans replacing the usual engine-driven variety. Those fans operate only when a chosen maximum coolant temperature is reached. A French car attains the same result with an electro-magnetic clutch in the hub of an engine-driven fan. At last autumn's Motor Show, an ingenious British variable-pitch fan was shown, with flexible nylon blades the curvature of which was varied by a pushrod running from a thermostat inside the water pump: as the engine-driven fan is normally on the water pump, this arrangement is mechanically simple, but with a by-pass thermostat valve in the cooling water circuit, the centre of the water pump does not appear to be the ideal spot for sensing water temperature.

The widening spectrum of lasers

Collaboration in recent months between three British government laboratories has pushed the wavelength of radiation from a laser far into the infrared. This development of a water-vapour laser provides the first powerful source of radiation in a difficult "gap" in the spectrum between radio and light

by David Fishlock

THE infrared is a wide band of the electromagnetic spectrum lying between visible red light and the shortest radio waves. In fact, it comprises extremely short microwaves, from roughly 0.75 to 500 microns in wavelength (see Figure 1). A region of great fascination for the physicist, it has always presented a considerable challenge because of the difficulty of generating and detecting radiation of this order. Hence the region has been something of a "gap" in the spectrum, albeit one that has been closing slowly during the past couple of decades.

Physicists were slowly penetrating the region from the radio wave end when the invention of the laser, in 1960, leapt the gap and provided a generator of far shorter wavelengths in the near infrared (less than about 5 microns) and visible regions. During the past four years the immense effort that has gone into lasers has extended their range of available wavelengths into the ultraviolet on the one hand and deep into the infrared on the other. And the laboratory that can claim to have extended lasers further in both directions is the Services Electronics Research Laboratory at Baldock in Hertfordshire.

In a nice piece of collaboration last autumn L. E. S. Mathias and A. Crocker at SERL developed a laser that emits radiation at various wavelengths between 23 and 79 microns; that is, well into the far infrared. Their collaborators were M. F. Kimmitt of the Royal Radar Establishment, Malvern, and Dr H. A. Gebbie of the National Physical Laboratory (*Nature*, Vol. 201, p. 250). The research not only brought together three large government laboratories but is noteworthy for the way in which it made use of three different techniques, each the speciality of the individual laboratory.

Work at SERL had already demonstrated that laser action—an emission of coherent or very pure light by stimulated emission—could take place in molecules such as carbon monoxide and nitrogen, and that by pulsing the power supplied to certain mixtures very powerful beams of infrared could be obtained ("Notes and Comments", 5 December 1963). A mixture of helium and carbon dioxide, for example, had given a few tens of watts at 1.07 microns, in the near infrared. But the SERL research workers did not know how the emission took place, and had no reason to think that longer wavelengths might not be possible.

About mid-summer last year it was proposed that the three laboratories should unite to seek radiation in the far infrared from a gas laser. SERL would contribute the laser, and the other laboratories the detectors and spectroscopic apparatus.

The equipment used in the experiment consisted of an electrical discharge tube, 4.8 metres in length, filled with water vapour at a pressure of about 1 torr. Very powerful electrical pulses lasting about a microsecond, applied to tungsten electrodes sealed into this laser tube, stimulated an emission of infrared radiation.

This emission passed through a window and was reflected into a spectro-

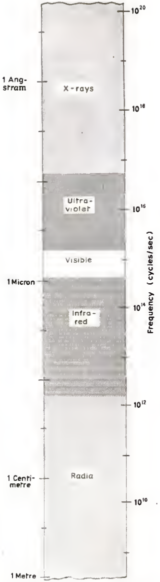


FIGURE 1. *Portion of the electromagnetic spectrum, showing the infrared region lying between sub-millimetre radio waves and visible light. The "gap" traditionally extends from about 100 microns to 1 mm.*

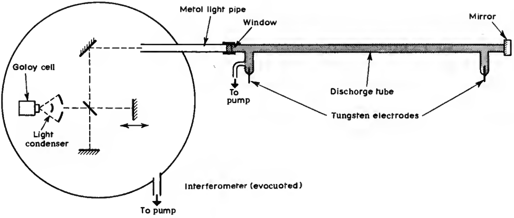


FIGURE 2. *Sketch of the laser and its detector system.* (After A. Crocker et *al., Nature,* Vol. 250, pp. 250-51)

scopic system consisting of a Michelson interferometer, a mirror condenser system and a Golay cell. The radiation falling on the cell was absorbed by its walls and heated the gas it contained, raising the pressure inside; the bulging of the walls could then be magnified and used to move an optical system. As a detector it is slow—it has a time constant of 0.1 second compared with the 3 microseconds of the pulse itself —but it is equally sensitive to all wavelengths.

RRE scientists, however, had developed a semiconductor detector with a response time of only 0.1 microsecond. It was a germanium device, doped with indium, and worked at 4.2°K—liquid helium temperature. The new detector could be used with a grating monochromator which also allowed pulses at the various wavelengths to be timed—a technique that could not be used with the interferometer system.

The team found nine different wavelengths of infrared radiation, the shortest 23.3 and the longest 78.8, all of which started and ended within the span of the applied pulse (see Table 1). The peak power at each wavelength ranged from 40 watts at 27.9 to only 0.2 watts at the longest wavelength. The team also confirmed that the radiation was, in fact, the result of laser action in the discharge tube, and was therefore "coherent".

A careful search was made for other wavelengths, though none was found using detectors with a range of 15 to 2000 microns. Neither was the team successful in establishing the source of the radiation, which may have been the water molecule itself, a hydrogen atom or hydroxyl radical, for example. Work along these lines is continuing between SERL and the RRE, though the NPL has now begun independent investigations.

The significance of the experiment lies in the fact that it provides physicists with a new and powerful source of infrared to supplement the rather pathetic sources they have worked with hitherto. The most versatile source previously available was the Sun, but hot bodies and the mercury vapour lamp were the usual laboratory infrared generators. The laser generator is likely to be used in, for example, "plasma diagnostics"—the investigation of the hot, electrified gases that may eventually lead to a controlled thermo-nuclear reaction.

Beyond the laboratory, there is immense scope for a source of infrared energy in the communications field (provided a wavelength can be found that is not absorbed by water vapour). The transmission of speech and video signals, and infrared "radar" for navigation and range-finding, could all become possible with this new source of radiation.

Wavelength* (microns)	Peak power** (watts)	t_1 (micro-sec)	t_2 (micro-sec)
23.3	15	1.4	0.4
27.9	40	0.9	1.5
28.2	8	1.2	0.5
32.8	3	1.0	0.4
47.3	2	1.6	0.7
47.8	1	1.6	0.3
54.9	0.6	1.6	0.3
78.1	0.2	1.6	0.6
78.8	0.2	1.6	0.5

t_1 is the delay between the start of the applied voltage pulse and the start of the output pulse, and t_2 the duration between the half-power points of the output pulse.

* The possible error is ± 0.4 per cent.

** The power lies between 1/3 and 3 times the figure quoted.

Table 1. *Emissions from the water-vapour laser.* (After A. Crocker, et. al., *Nature, loc. cit.*)

Aviation in 1984

Market needs and technical possibilities

by Dr M. J. Lighthill, FRS
Director, Royal Aircraft Establishment, Farnborough

TWO separate streams of development generate, by their imperfect interaction, the changing pattern of aviation. One is the development of market needs, whether for military or civil aircraft. The other is the development of technical possibilities, whether for engines, airframes or aircraft equipment.

To forecast the pattern of aviation in 1984, it is necessary to survey the conceivable patterns of development of market needs (as influenced by likely technical innovations) and judge which is most probable, and also to survey the conceivable patterns of development of technical possibilties (as influenced by likely market requirements) and judge which of them is most probable and, finally, to forecast the most likely result of the interaction of the market needs and the technical possibilities.

Market needs: military.—The military requirements, which hitherto have represented the greatest part of the market for aviation products, are the part hardest to forecast twenty years ahead. Futures that are, no doubt, possible include total disarmament and, as the opposite extreme, devotion by the most highly developed nations of an increasing proportion of their increasing productive capacity to preparation for wars of every conceivable scale and duration.

Like many others, I am inclined to reject these extreme hypotheses. Concord among the nations may, as we fervently hope, reach the stage when peaceful machinery for settling cases where powerful interests are in conflict becomes accepted. It is unlikely, however, that those powerful interests could tolerate a situation in which irresponsible local disputes might develop unchecked into war. On the most optimistic view that appears tenable, armed forces would be needed, able to deploy substantial force at very short notice to any trouble spot. One may speculate whether such forces should in normal conditions be concentrated (for efficient training) dispersed (for maximum deterrence) or both, but probably in all cases they would need to be capable of rapid long-range reinforcement. This role, with others such as reconnaissance and strike, would be expected to make continued demands for efficient air power. Manned interceptors might also be necessary to interrogate suspicious aircraft, since lawbreakers could easily acquire dangerous offensive strength by converting civil aircraft.

Alternatively, law and order in 1984 may be maintained, not by one mobile, flexible and efficient world force, but by the continued balance of opposing forces. However, one may expect the nature of such a balance to be increasingly changed by the fact that a very few groups can convince other groups of their ability to cause more destruction, in those other groups' homelands, in the first few hours of a conflict, than in all previous wars put together, independently of any destructive action by the other side. The chances that a nation may seek to develop defensive or pre-emptive forces capable of invalidating a second-strike threat against it, are likely to recede, owing to the crippling increases in the cost of such a system that appear achievable by relatively cheap increases in the degree of sophistication of the second-strike threat itself.

The greatest nations may then be able greatly to slow down the development of new strategic retaliatory forces. On the other hand, their interest in being able to limit local conflicts drastically, in respect of intensity, area and duration, will increase. They, or alliances of which they form part, are likely to need highly mobile, versatile and effective forces for use in limited war. Indeed, the only qualitative difference from the type of force discussed under the previous hypothesis would lie in the need to be effective in the possible presence of well-equipped opposition.

To sum up, the market needs for military aircraft in 1984 may be dominated by the need for highly mobile forces able quickly to bring under control an explosive situation anywhere in the world. Effective transport, not too dependent on facilities at the destination point, with reconnaissance, strike and interception, must be provided. Serious doubt remains, however, on how well equipped a defence such a force should be organised to cope with.

Market needs: civil.—The civil requirement for aircraft has grown fast since the second World War. Few people doubt that it will continue to grow, but the rate of increase is not easy to predict. The number of passenger miles flown on scheduled flights increased about fourfold in the decade between 1950 and 1960. Rising standards of living, reductions by about 30 per cent in the average fare paid (relative to the general price level), and increasing spread of "international awareness" are guessed to have contributed to this. Most people guess that similar factors will operate in the next two decades, but with somewhat less total effect; possibly a two-fold increase between 1964 and 1974 might be followed by a further 1½-fold increase by 1984. But the precise rate of increase is believed to be highly sensitive to such fare reductions as may be offered, so that one of the most important requirements for new airline types will be economy of operation.

Apart from the appeal of air travel to individuals, great political and commercial interests benefit very substantially from a system that makes all parts of the world rapidly accessible and, partly for this reason, governments commonly assist civil aviation, although giving it every possible inducement to pay its own way.

Governments, furthermore, in many countries, have been most effective, through regulation, research and education, in promoting safety in civil aircraft operations. The present average fatal accident rate on scheduled services, of 1 per 100 million passenger-miles, means that on the average an individual may expect to pay about £3 million in fares before meeting with a fatal accident. The process of further reducing the risk to crew and passengers, must, however, continue.

It is sometimes imagined that speed is the enemy of economy and safety, and that airlines are forced to higher-speed aircraft only on the basis of their undoubted passenger appeal. Hitherto, however, economy and safety have actually improved with increase of speed (which increases the miles flown per aircraft per annum). Supersonic airliners are, from the start, being designed around the existing standards of economy and safety. In addition, it is expected that experience with their production and operation will show how the increased seat-mile productivity which supersonic speed permits and the perfection of new safety techniques such as automatic landing, will, ultimately, allow both to be improved upon. The design of these and other new civil aircraft is limited by one other main consideration, namely, that annoyance caused on the ground by their emitted sound, cannot be allowed to rise above somewhere about its present level.

The civil market includes the use of aircraft for freight, agricultural and survey purposes, which can also be expected to grow very fast indeed in the next twenty years. Economic and safety considerations will again dominate the rate of future expansion; but there are already many parts of the world where aerial seeding, top-dressing and pest control, in particular, have shown a very handsome profit, in spite of difficult safety considerations.

Technological possibilities.—From what has been said, the difficulty of forecasting with any precision, the requirements for aircraft coming into service in 1984 must be evident. But, even if second sight allowed this, it would still be impossible to pinpoint the developments, aimed at meeting those requirements, that are most likely to attract adequate capital support in the 1970s. Among many reasons for this, an important one is the certainty that another ten years of accumulation of new knowledge in a technology where the pace of research is hot will cause big changes in the balance of expected advantage between one development and another.

One must, then, recognise many more technological possibilities for future development than will ever come to fruition. In the selection of those that I shall mention, I may appear to be taking out and redusting certain ideas of respectable antiquity. For example, on laminar flow, much work was in progress already during the second World War. In many of these cases, however, one should speak not of antiquity but of maturity. A good idea in aeronautics constantly evolves, as more and more essential engineering detail is elucidated and what the idea can achieve is becoming more precisely known. At the same time, those achievements have to be matched to constantly changing needs, and the new balance between potential and need has constantly to be reviewed.

Of course, an idea continues to mature long after first flight and the very best ideas in aeronautics have exhibited astounding resilience and vitality. For example, the classical straight-wing-tail-fuselage combination showed almost endless capacity for development and continues to be selected against requirements for runway-based aircraft operating over short stage-lengths. A later configurational idea, the use of swept wings with careful fuselage and wing shapings near the kink in the lifting surface, is already of respectable antiquity, but promises well, as we shall see, for further development.

Similarly, no doubt, newer aerodynamic ideas, like the sharp-edged slender delta of the Concord or, beyond that, what we may call the "lifting propulsive duct", have extended futures ahead of them, and any such idea may be combined, as time goes on, with many different motifs in the structural, propulsive and systems fields.

Laminar flow.—The drag of an aircraft arises from energy fed by it into the air through which it flies. One part of this energy goes into creating the downward air movement (a double vortex) necessary to give the aircraft lift, but another part goes into the useless wake, by friction between the aircraft surface and the air near it. Under normal conditions, the thin shearing layer where the frictional forces act does not have airspeed distributed across it in a laminated manner, because that flow condition is unstable; instead, the layer breaks up into turbulent eddies, which transfer much more energy to the surrounding air than simple viscous action would do. Over twenty years' work has demonstrated that, by sucking part of this layer through either a porous or a slotted wing surface, what remains can be rendered stable, partly because it is so thin and partly because the distribution of airspeed across it is conducive to laminar flow.

Experiments in flight continue, and difficulties remain to be overcome, but it must be regarded as a serious possibility that an important increase in payload or range may have been obtained by these means in some aircraft for civil or military purposes or both by 1984.

FOURTH WEEK OF THE 1984 SERIES

In this series the contributors have been asked to forecast conditions in 1984 on the basis of known possibilities and trends. It is recognised that a certain amount of guesswork is unavoidable and that unforeseeable discoveries and inventions could, in some cases, radically alter the picture.

Next week: "Health in 1984", by Sir John Charles, Professor Sir Charles Dodds, FRS, Professor Z. M. Bacq, and Professor Sir Aubrey Lewis.

All-wing aircraft.—The possibility of all-wing designs for transport applications, to make the whole structure bear the lift to balance its weight, with the aim of reducing the loads to be transmitted through it, has often been studied. Many difficulties arise, but techniques for overcoming most of them are under development.

Combination of this idea with laminar flow has its attractions, since "laminarisation" of fuselages is difficult. Looking far into the future, one may suppose that beyond the first generation supersonic airliner, which is already half-way towards being an all-lifting surface, the next step might be laminarisation (which could in principle improve supersonic economics even more than subsonic) in combination with an all-wing design.

Without laminarisation, the all-wing concept shows some promise also for economic short-range operation—a specialised role in which the main difficulty of compact all-wing designs, namely a reduced lift-drag ratio at low speeds, is of reduced importance.

Variable sweepback.—This application of the swept-wing idea has also had to wait a long time before engineering practicability and market demands were matched, in the American TFX project. This is designed to meet a military requirement in which the emphasis is on flexibility, that is, in appropriateness to more than one service, to the strike and interception roles, etc. An important feature of the aircraft will be low fuel consumption during loiter in the straight-wing condition and high supersonic dash capability in the swept-wing condition.

What can be expected of second-generation variable sweep aircraft? Present researches offer at least the hope of wing shaping yielding really high lift-drag efficiencies at two quite different "cruising" speeds, subsonic and high-supersonic; this might have several applications. At the same time, the permanence of the "hinge" method of varying sweep is not certain. In theory an all-wing shape might be designed, that could be flown as a straight wing at low speeds and "slewed" round as a whole by up to 70° to the direction of flight at high speeds to reduce drag. Improvements in automatic control techniques might render asymmetrical flying of this kind possible in the future.

Aviation in 1984 *continued*

Speed.—One idea, of, indeed, more respectable antiquity than any is that aircraft speeds can with benefit be increased. A "barrier" to further speed increase has from time to time been alleged; but past barriers were successively broken by the evolution of the clean-aircraft concept (sometimes called "streamlining"), the development of the gas turbine, and the abandonment of straight wings — in each case with an improvement in operational economy. The present barrier to practical use of higher speeds than "Mach 2 plus", namely the "heat barrier", is almost certain to be similarly penetrated in the years ahead.

In the meantime, it has been circuitously circumvented by the development of spacecraft, lifted out of the atmosphere by rockets before acceleration to speeds ten times more than "Mach 2 plus". They avoid the atmospheric-heating barrier, but the speeds needed to remain in orbit are inconveniently high for many practical applications.

The question arises, therefore, whether, in addition to this "revolutionary" approach to increase in speed, there exists the possibility of an "evolutionary" approach, beginning say with aircraft capable of speeds up to Mach 5 and heights up to 125 000 ft, aimed at appropriate market needs. New shapes which appear likely to be suitable for such aircraft include "wave riding" shapes which "ride" a shock wave in the manner of a planing hydrofoil, and in which propulsive and lifting systems are no longer of a different order of size and therefore have to be designed as a single whole. They may augment lift at the highest altitudes by jet deflection. The airframe structure may use materials hitherto reserved for the hot end of jet engines; the engine itself, and the cabin, will need elaborate cooling systems giving up heat to unburned fuel and probably also to water. A particularly difficult feature will be the matching of aerodynamics and propulsion to the low-speed as well as to the high-speed flight regime; variable geometry will again be needed, possibly in the lifting surfaces, but certainly in the engine installation.

Vertical take-off. — The pioneering of vertical take-off in the UK seems likely to be followed by worldwide adoption in a variety of roles. The immediate improvements that can be foreseen include development of instrumented landing and take-off to permit economic operation under all conditions with minimum (and, where necessary, zero) site preparation.

In those military applications, at which current orders for VTOL aircraft are aimed, it may in addition become more and more desirable to be able to use any relatively flat area that may be available to increase payload or range (or both) above their values for pure vertical take-off. The evolution of designs with favourable "ground effect" (the principle used in hovercraft) might help here. If the lift on a VTOL aircraft when only a few feet above the ground were double the jet thrust, it might accelerate at this height over soft, uneven terrain until aerodynamic lift made up the balance.

Civil application of VTOL must be preceded by substantial noise reduction, which for lift engines whose thrust exceeds the aircraft weight appears very difficult unless the thrust is achieved by accelerating rather large amounts of air to only moderate speeds as in the rotorcraft. However, limitation in rotorcraft speeds is one of the factors that make it difficult to match fixed-wing economics at present and it is possible that quiet, economic operation between city centres will become possible only when the undoubtedly extreme difficulty of retracting the rotor into the fuselage of a conventional aircraft shape has been overcome.

Automatic control. — Finally, it is worth observing that the increases in reliability of automatic control equipment, and reductions in its weight, foreseeable from a combination of microminiaturisation and redundancy in circuit design, may make possible a new sort of flying, in which all routine control and decision-making is done by a computer, and only the exceptional situation that seems to require the exercise of human judgement is referred to the pilot. If experience with such "super-reliable" circuitry ultimately leads airworthiness authorities to accept aerodynamically unstable aircraft — designs that would be unstable if the control system were to fail — economies should be possible, since present designs are substantially compromised by stability considerations.

Reader participation. — The problem of deciding how the range of different technological possibilities and of conceivable future patterns of market needs that have been described in this article will combine to determine the aviation scene in 1984, is left as an exercise to the reader.

Travelling by air in 1984

by Pierre Satre

Technical Manager, Sud-Aviation

THE development of commercial air transport depends upon two factors. Firstly, general economic progress and international relations result in increasing demand, and the continuing response of the air transport companies must lead to improved service to passengers at lower rates. Secondly, technical advances enable operators to benefit from better performance of the aircraft used — the term "performance" embracing the entire range of operational characteristics, including the operating cost. These factors are interconnected. The increasing demand stimulates the creation of improved machines. The use of new aircraft, of higher performance, means that more and more clients will make use of air transport.

Figure 1 shows the progress made in world air transport between 1945 and 1962, according to ICAO statistics. Can we, from such a graph, calculate the probable increase in air transport during the next twenty years? We do not propose to do so here, as we shall consider only the technical aspect of the problem. One thing is, however, certain: the demand will continue to grow. To promote this growth, it will not suffice simply to increase the speed. Mass transportation, at lower fares, will also be a goal and the air traveller will be offered much more frequent services and more convenient schedules.

Technical progress. — The factors governing progress are to be found both in the improvement in the existing concepts and in the introduction of new ones. If, by their very nature, the latter defy forecast, one can nevertheless note the very great acceleration in the rate of technical progress made during the past few decades. It

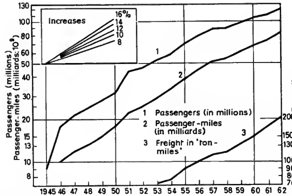


FIGURE 1. *Progress of world air transport from 1945 to 1962 according to ICAO statistics. This graph has been prepared with a log scale for the ordinates so that the direction of the curves indicates the increase in traffic as a percentage. Thus between 1958 and 1962 the average annual increase in ton-miles was 8.5 per cent for passengers, 11 per cent for passenger-miles and 16 per cent for freight.*

took forty years, from the time of the first closed circuit flight, for aircraft to reach the speed of sound in level flight; then a further five years to double this speed. Five years after that, we reached orbital speed. If, however, we consider only transport on our planet, there are two factors which will lessen and ultimately limit the increase in supersonic speeds:

(1) The cost of the more advanced aircraft is such that airlines demand a service life of at least ten years or even 15, to allow for reasonable amortisation. Thus, the first supersonic aircraft, the Concorde, of SUD-BAC, scheduled to enter service at the beginning of the next decade, will be operating at least until the year 1980, and the last aircraft in the series will be operating for a considerably longer period than that.

(2) The size of our planet is such that there is no point in increasing the speed beyond a certain limit (especially when it is considered that the time the traveller has to spend on the ground is by no means diminishing at the same rate as that of the flying time).

Evolution of DOC. — The Direct Operating Cost is the airline's outlay for the flight as such — that is, apart from all the additional expenses of a commercial nature. Expressed in terms of currency per seat offered and per mile flown, it varies according to the stage length. The DOC is a good criterion of technical progress.

If we now include, in one and the same graph (Figure 2), the curves relating to typical transport aircraft at different periods, we are struck by the continuous trend towards lower rates. This reduction can be explained by the fact that the DOC varies inversely with the speed and the capacity of the aircraft — factors which have always been increasing since air transport began. This increase will continue over the next twenty years.

Other service improvements. — Under pressure of the demand, the airlines will be compelled to make numerous improvements in their services, 'improvements by which the traveller will benefit directly and, again, indirectly by the effect of these improvements on the operating cost. Thus, reduction in the turn-around times (by a further study of the non-technical "handling" services such as the cleaning of the aircraft) will allow an increase in aircraft utilisation, and therefore in the number of hours flown per annum. Similarly we can expect reduction in the holding times before landing, which are very costly for the operator and most unpleasant for the passenger. I will add, in this connection, that in my opinion, the essential advantage of the vertical take-off aircraft, if it becomes a commercial proposition, does not lie, as is commonly believed, in the possibility of arriving and departing near the city centres. That is an illusory advantage. Instead, VTOL will allow, perhaps, a large number of simultaneous take-offs and landings at one and the same airport, and this would represent real progress.

The application of "*economy*" *fares* to local services, at off-peak periods, and the extension of air-shuttle services at specified times without reservations, are two steps which, whilst they will probably bring in many new passengers, will again increase the load factors and the utilisation rates of the aircraft.

For some years past, the increasing importance of *regularity* of service has been recognised by both aircraft manufacturers and airlines. Regularity depends mainly upon technical advance and we can be sure that considerable progress in this field will be made during the next twenty years. On the one hand, the study of *reliability*, a new science which has developed as a result of space research, will allow reduction in the number of failures and of slight incidents which delay flights or immobilise the aircraft, whilst they will at the same time lead to the lowering of maintenance costs. On the other hand, the improvements in navigation methods: the Doppler system, and afterwards the inertial system, improvements in very short-term weather forecasting (through the use of satellites) and especially *all-weather landing systems* such as Sud-Lear Siegler will reduce the number of cancelled flights or diversions and will ensure almost 100 per cent regularity of flight, irrespective of season or latitude.

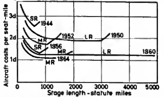


FIGURE 2. *Direct operating cost versus stage length for typical transport aeroplanes from 1944 to 1964. SR—short range; MR—medium range; LR—long range.*

I will also mention here the expected increase in the use of computers and automatic checking systems, which will relieve present burdens on the pilots.

Specialised aircraft. — The design of specialised aircraft according to the route pattern and the volume of traffic is one of the ways in which one is tempted to go to obtain lower fares. The advantage gained, however, by this specialisation must be sufficiently important to meet the competition of: (1) down-graded aircraft which, whilst not so well adapted, has the advantage of a purchase price which is often

Aviation in 1984 *continued*

very low; or (2) of new multi-purpose aircraft whereby the operator does not get quite 100 per cent benefit in each mission but which is, in the end, more profitable, thanks to the saving made by standardisation of aircraft and spare parts.

Transport aircraft in 1984.—Bearing in mind the foregoing, and considering only the concepts in course of development during 1963, let me try to outline the characteristic features of the airline fleets in 1984.

(1) *Almost exclusive use of jets on all routes*.—Although, at present, in the minority (18 per cent of the number of aircraft, but more than 50 per cent of the productive capacity) jets will gradually preponderate in all fleets. The turbo-prop aircraft will see their share reduced as a result of constant progress in fuel consumption made by turbofan engines.

(2) *A large majority of supersonic aircraft on long-range services*.—Cruising at speeds from Mach 2.2 (1260 knots) to Mach 3.5 (2000 knots), supersonic aircraft will be used on long transcontinental and transoceanic routes. The Antipodes will be reached in six to seven hours' flying time. The types of aircraft in service will be the Concorde and the future American supersonic aircraft.

Supersonic aircraft on medium-range services.—The operational flexibility of supersonic aircraft of the Concorde type will be such that the airlines operating them on long-range routes will also fly them on the medium-range extensions of their networks. In the USA, direct coast-to-coast links will be provided by aircraft of this type.

A wide range of types on all other routes.—According to the size of the airlines and the areas served, the volume of traffic and the length of each stage, we shall see in use short-take-off aircraft, subsonic and supersonic aircraft, aircraft of a seating capacity of 40 to 200 passengers, two-, three- and four-jet aircraft. Turbo-prop aircraft may perhaps continue to be used either for cargo transport on long hauls where they will be justified by a saving in fuel, or on very short ranges, for the short take-off aircraft, because the use of propellers is an important factor where slow-speed flight and short landing distance are concerned.

Positive increase in freight transport.—The tendency, indicated in the graph in Figure 1, will become more marked and freight transport will be a growing item in airline revenues. This development will be spurred by the designing of new aircraft, turbo-prop and jet which, thanks to their technical refinements, will make it possible to reduce prices still further.

Conclusions.—Whatever anyone may say, the quest for higher speeds constitutes a major incentive to progress in air transport. The study of the technical problems raised by supersonic aircraft contributes, indirectly and with a time lag but nevertheless undeniably, to progress in all aircraft, by increased knowledge of all aspects of manufacture and flying. To take a recent example, the gas-turbine was developed, in the first instance, to achieve higher speeds, yet it is used today in all new models of transport aircraft, including the slowest, and it is thanks to the gas-turbine that the helicopter has become a most useful machine.

Progress in materials, in constructional methods, in propulsion, in reliability, in methods of control and navigation, in landing systems—in fact all this progress, stimulated by *supersonic aircraft*—will be found, in one form or another, in all the aircraft constituting the fleets of 1984, throughout the whole range of speeds. It is, in part, thanks to it, that qualities of safety, regularity, flexibility in operation, and economy of this equipment will achieve a very high level, which, in turn, will ensure the continuous development of air transport.

Towards complete safety in the air

by R. M. Macdonnell

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ANY glance over the technical aspects of air transportation in 1984 must pause at the problem of safety. Safety, of course, is relative; today's accident rates would have been regarded as unexpectedly low by the airline pioneers of thirty years ago, and even ten years back the fatality rate was nearly twice as high as it was in 1962. Yet the total number of airline passengers killed in 1952 was only 386, while in the so-called "best" safety year of 1962 the number was 765.

The reason, of course, is the yearly increase in the number of people who fly. ICAO's statisticians anticipate that 1984's air traffic will be three or four times as great as today's. If this should prove to be the case, and unless there is a radical decrease in the accident rate, the mounting total of passenger fatalities may produce a public reaction which could seriously injure air transportation. From this it would seem that the first aviation requirement for the developing technology of the next two decades is the improvement of air safety. Let us consider some of the ways in which this improvement is likely to come about.

The first requirement is the removal of that greatest cause of accidents: human error. Human error can mean a pilot's misjudgment in landing, a traffic controller's miscalculation, a mechanic's failure to insert a lock washer in a critical assembly. In twenty years it may well be possible to avoid human error completely. Much of the answer will be in automation. Even today it is possible to land an aircraft without human hands at the controls; it is probable that the pilot of 1984 will still make the decisions, but that his aircraft will do the mechanical things for itself—will fly itself, navigate itself, take off and land by itself. The problem now is in reliability, in our present inability to build electronic equipment which can operate for a sufficient length of time without the possibility of failure. We get around this problem to some extent today by what we call redundancy, by using two or three pieces of similar equipment—when one piece fails, the next one takes over, and so on—but this technique is expensive and the extra weight to be carried often rules it out as a possibility. New developments in solid-state physics, the use of the transistor, the ability to incorporate a multitude of electronic circuits in a minute sliver of material, the elimination of the heat put out by thermionic valves—all of these promise the ability to build inexpensive, light-weight electronic equipment with many back-up circuits, so that if one or even more than one should fail, there are always other circuits to take up the responsibility. In fact, it is even possible to anticipate the construction of electronic equipment which requires no servicing for the life of the aircraft.

In aviation history, small maintenance errors have frequently produced appalling results. This problem, too, must yield to automation. A precedent is already available in the automatic inspection devices used in the United States before missile launchings. I can conceive of a similar device built into each aircraft, allowing a speedy, exhaustive and accurate inspection of every critical point and, among other things, catching any defects due to maintenance or wear. I would also expect that by then we would have a better theoretical knowledge of metal fatigue and an ability to design most fatigue defects out of our engines and airframes. In the few places where these defects will still exist, mechanical redundancy may also be called upon.

Other aspects and results of automation will show in air traffic control and communications. Today, an air traffic controller's job is a combination of tedium and action; he has many moments of routine, keeping track of aircraft movements, for each moment when he must make an intelligent decision. It will be the role of the computer to take away the routine functions of the controller, to keep a record of each aircraft's movements and the possibility of infringement upon another aircraft's airspace; it will free the controller for his important work, which is the use of his experience and judgment to keep traffic flowing smoothly and efficiently, and to avoid collision. A reliable airborne collision avoidance device would, of course, simplify traffic control procedure greatly, but there seems to be valid doubt that such a device will be available even in twenty years.

We can expect a mixed bag of transport aircraft by 1984, including long range supersonics, medium range supersonic jets, and short and long range VTOLs (vertical take off and landing), and our air traffic control system will have to be able to handle the different varieties. Accurate navigational equipment will be supplied, either self-contained inertial-type or a ground-based, world-wide low-frequency radio chain. The traffic control computer will know the whereabouts of the aircraft at all times. As long as the aircraft stays with its flight plan, the computer will keep its changing position in mind; as soon as there is a significant deviation from the flight plan, the aeroplane will automatically report this deviation to the computer to keep its knowledge up-to-date.

All this presupposes an improvement in our present air-to-ground communications facilities, now somewhat overloaded. The possible abandonment of routine position-reporting will help to ease this strain, but in addition we shall have to go to much higher radio frequencies, and rely upon communications satellites to relay the line-of-sight messages beyond the horizon to the traffic control centre.

The simplification in air-to-ground communication will result in far more need for communication between points on the ground. The computers in adjacent traffic control centres will have to keep in touch at all times. This means that we shall not be able to rely on communications channels which can be affected by the vagaries of the ionosphere—and this rules out the HF band. The alternatives are either land-line relays or satellite relays, in both cases using microwaves with multi-channel capabilities. Another possibility, and one which shows perhaps the most interesting promise, is the laser; one laser band, operating through silvered plastic tubes running under the ocean from Europe to America, could carry all the communications now being carried on radio frequencies, and still have room for several thousands of television channels.

Along with human error and insufficient traffic control capabilities, unexpected weather is an important item in today's accident reports. We can certainly look forward to a vastly improved weather reporting and forecasting system. We are now, with the appearance of meteorological satellites, on the threshold of a great advance in the field; for the first time we shall have accurate reports on weather conditions in many parts of the globe where there are no reporting networks and, from these "actual weather" reports, I think we can reasonably expect a considerable improvement in our knowledge of why the weather behaves as it does. Even today computers can predict expected weather as well as human forecasters; with better theoretical knowledge, we may expect by 1984 that forecasting will be in the hands of the machines, leaving only meteorological research for humans.

Weather "actuals" rather than forecasts will then be the key to aeronautical meteorology. With weather satellites to give us a true, constantly-changing picture and with computers integrating this information constantly instead of—as at present—at six-hour intervals, with other new reporting devices and with automatic interrogation of aircraft in flight whenever the computers need the information, we can expect good, moment-to-moment knowledge of both upper air and surface conditions. Oddly enough, as forecasting improves it will become less important, for flight times will become shorter, with three hours coming close to maximum. (True, the London-Australia run by non-stop supersonic aircraft, would come close to twice this time, but I suspect that even by 1984 the fuel load needed for such an operation will make the non-stop flight uneconomical.) In other words our knowledge of actual weather conditions will be so accurate, our needs for forecasts will cover so short a period, that in effect we shall be able to remove the element of surprise from meteorology.

This leaves only one major meteorological problem: clear-air turbulence. So far the causes are unknown, but the effects on high-speed aircraft can be disastrous. All that can be said at the moment is that we hope to be able to predict the presence of clear-air turbulence before 1984: certainly if we do not succeed, high-speed flight will not be as safe as it should be.

This has been a short review of some of the basic improvements we can expect in the field of air safety twenty years hence. These improvements will be costly. We shall need so much more than we have at present in the way of air navigation aids and facilities—and yet, even today, our basic problems in many parts of the world arise from an insufficiency of trained men coupled with an insufficiency of funds. Much is now being done to improve the supply of technicians; many less-developed countries are running their own training plans in addition to those operated by ICAO for the United Nations Special Fund and as projects under the United Nations Technical Assistance programme. Yet the demands of aviation continue to grow from year to year, and we come no closer to fulfilling them: like Lewis Carroll's Red Queen we have to run as hard as we can to stay where we are. Unless this situation improves radically in the next twenty years, 1984 will have the technical knowledge to produce complete air safety, yet accidents will still occur.

Another way of looking at the cost of smoking

THE publication of the United States Surgeon - General's report on the link between smoking and disease has revived interest in the Royal College of Physicians' report *Smoking and Health* (see *New Scientist*, 8 March 1962, p. 552). Workers at the Chester Beatty Research Institute have translated the situation that was implied in the Physicians' report into terms more immediately applicable to young people. They are printed below.

As many predictions must be, the figures are only a rough indication of what may transpire. They were calculated from forecasts of death rates from all causes, from bronchitis, and from lung cancer (see opposite), which may reasonably be expected to apply to the people born in England and Wales in 1941 (the 1941 "cohort"); taking in the number of smokers in the population, the average number of cigarettes they smoke, and the differentials of death rates in Table A.

Ratio of death rates, smokers/non-smokers	Males	Females
Lung cancer	15	10
Bronchitis	6	4

Table A.

The figures below speak for themselves; smoking can no longer be regarded as a hazard which will affect only a small proportion of those who indulge in it. Moreover, seen in the light of the "Social Balance Sheet", it is useless to plead that smoking is purely a matter of personal choice. The habit has very considerable social repercussions, including one that has previously largely escaped notice—namely marital bereavement.

"SOCIAL BALANCE SHEET"

The estimated effect of the continuation of the present pattern of smoking habits on the future life of young persons at present age 15 years with respect to the lethal effect of the association between smoking and lung cancer and bronchitis only.

Each year, at about the age of 15 to 20 years, young persons are forming the smoking habits which lead to the present social situation in which, at ages over about 25, 75 per cent of males have become smokers with an average consumption of 20 per day and 50 per cent of females have become smokers with an average consumption of 10 per day. (Cigarette smokers only are being considered.) One of the simplest ways of translating the effects of this situation into terms of some of its social consequences is to regard the population as being made up of successive waves of people aged 15 in each successive year and to follow the fate of one such wave. The 1960 population estimates for England and Wales record 337,000 males and 321,000 females aged 15. These figures were used as the base for these calculations.

1) Effects referable to the individual

	MALES	FEMALES	
Loss of expectation of life of average smoker compared with non-smoker. From age 15.	13.4	14.8	In years
(Referable to those who die of smoking.)	5.5	5.5	In hours per day
	MALES	FEMALES	
Chances of person now age 15 who becomes an average smoker dying prematurely from a cause associated with smoking One in	4.5	17.5	

(2) Effects referable to more than one individual

The differences of the age-specific death rates of the two sexes lead to an average level of marital bereavement for partners of stated ages. Smoking is associated with changes in these rates and some of the implications are as follows :—

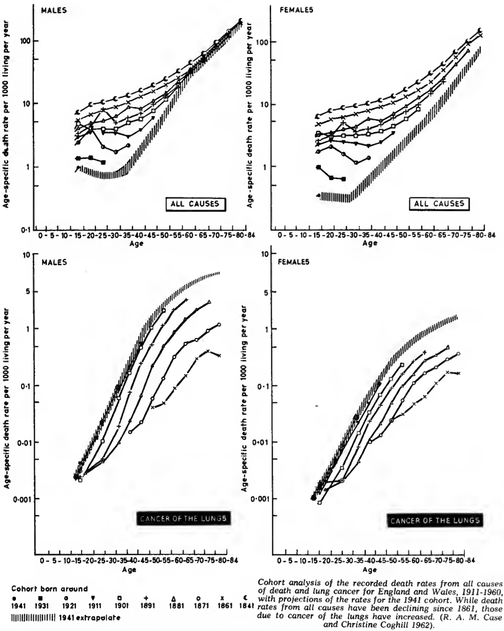
		ONE IN	RELICT
Chances of a marriage between partners both aged 20 ending in marital bereavement before the age of 65 because of a death associated with smoking	Non-smoking female with smoking male	13.5	Widow
	Smoking male with smoking female	13.7 66.7	Widow Widower
	Smoking female with non-smoking male	62.5	Widower

3) Effects referable to the community

The community will suffer from the loss of life associated with smoking among the smokers as compared with the life-expectations of non-smokers expressed in person years and also from the actual number of deaths associated with smoking that will occur amongst the smokers. Since this balance sheet refers only to the future life of persons aged 15 this year a similar bill will be incurred for every year the present situation continues.

	MALES	FEMALES	TOTAL
Person-years of life lost from deaths associated with smoking which will occur amongst persons at present age 15	755 000	136 000	891 000
Number of deaths associated with smoking which will occur amongst persons at present age 15	56 406	9208	65 614
Proportion of average smokers whose deaths will be associated with smoking	One in 4.5	One in 17.5	—
Cigarette tax (at the present rate) which will accrue to the community from one year's intake of persons age 15 during these persons' life-time	£664m.	£241m.	£906m.
Average amount of cigarette tax (at the present rate) which will be paid by each smoker during his or her life time	£2628	£1500	—

R. A. M. Case and Christine Coghill, 1962.



Cohort analysis of the recorded death rates from all causes of death and lung cancer for England and Wales, 1911-1960, with projections of the rates for the 1941 cohort. While death rates from all causes have been declining since 1861, those due to cancer of the lungs have increased. (R. A. M. Case and Christine Coghill 1962).

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from Howard Simons

Disarmament in the doldrums

ANN ARBOR

Much of today's disarmament research seems to have the forward progress of a spent bullet. At least that is the impression one got from listening and talking to the experts who gathered here at the University of Michigan for the three-day Second International Arms Control and Disarmament Symposium.

A Soviet affairs expert, Marshall Schulman, was the harshest public critic of current research. His major complaint was that the research was out of touch with political reality. For example, he told his colleagues, most people active in the field do not understand sufficiently the depth of conflict between the ideologies of East and West. He drew no distinction between government and non-government researchers. In Schulman's view the stage has been reached "where it is both possible and necessary to think of measures that can be taken to reduce the hazards of war while realising that the ideological conflict (the political and economic battle) can continue unabated."

Nor was Schulman's pessimistic assessment of today's arms control and disarmament research the only one. Several other participants, publicly and privately, voiced similar unhappiness. It seems that there has been essentially no really new idea on the subject since the late 1950s. Many of the most original minds in the field have moved on to other worries. Moreover, government, upon whose dole the non-government disarmament researcher depends, has pre-empted much of the most significant research, especially that concerned with matters politic, which Schulman finds lacking. Consequently, many non-government researchers, most notably those without influence in Washington, are frustrated. And it is beginning to show.

Characteristically, Katz had his own notion about what is wrong. Essentially, it is that the disarmers' worst fear—disaster in the absence of disarmament—has not materialised. On the other hand, nor has the implementation of the disarmers' most elaborate schemes for preventing disaster. But whatever the reason, or wherever the fault for the apparent sterility of today's disarmament studies, the criticism was underscored here by the fact that there was virtually no discussion at the symposium of President Johnson's proposals tabled at Geneva only the day before the symposium began. Rather, the prepared papers presented to the gathering represented a wide diversity of schemes, analyses, and what journalists would readily recognise as "think" pieces. If there was a pattern, it was spottiness.

*

SOME OF THE studies classified the obvious. Thus, Edwin H. Fedder of Hollin's College, Virginia, after some study, concluded that there was little prospect that the US Senate, as presently constituted, would ratify a disarmament treaty. At one of the few sessions given over to political reality, Elijah B. Z. Kaminsky, of Arizona State University, said that prospects are dim even for trying to bring France screaming and kicking into disarmament discussions. "A reversal of the policy of the 'force de frappe'," Kaminsky said, "would facilitate, but would not render inevitable, French participation in practical arms control. However, it is unlikely that internal political changes will result in such policy reversals.

"Reintegration of the French Army into a democratic France is thought to necessitate appeasement of the Army's discontent by turning its attention to the development of nuclear military technology, and this, in turn, gives certain sectors of French big business a significant stake in the 'force de frappe'. Even Frenchmen opposed to the 'force de frappe' on its merits resent the attempt of outsiders, including would-be arms controllers, to dictate French military policy."

In commenting on Kaminsky's paper, Schulman said there was no basis for indulgence in looking at present French policy. He labelled it "belated nationalism" and suggested that it was brought about in some measure by imprecise US policies. French policy, he said, endangers not just disarmament efforts, but the United Nations and the Common Market. Unless checked, Schulman thought, the present French course could have a surprise ending—it could make West Germany the dominant economic, technical and military power in Western Europe.

*

AT THIS SAME session, one of RAND's China experts, Alice L. Hsieh, painted a dark picture of the prospect of getting Communist China to the disarmament conference table. Mrs Hsieh said that the Chinese, like the French, were using the acquisition of nuclear weapons and their disdain of disarmament measures as instruments to pursue long-term political objectives. In the case of China, one of these objectives is to whittle and erode American influence in Asia. Another, obviously, is to break the Soviet monopoly on nuclear arms among the Communist bloc nations. In Mrs Hsieh's view, a precondition for Chinese Communist participation in agreements such as the limited test ban treaty would be US recognition both of Red China and its claim to Taiwan. She concluded that, although a more conciliatory leadership might eventually come to power in China, or the Russians might be able to buy the Chinese signature on treaties, "trends like these are not observable at the present time".

Three Soviet diplomats at the symposium added nothing new to the record and refused comment on Mr Johnson's proposals. On the other hand, a Polish diplomat, Marian Dobrosielski did have something to offer: an elaboration of the limited Rapacki plan which the Poles, in consultation with the Russians, are planning to offer to the West, presumably at Geneva. First word of the plan came from Mr Gomulka, the Prime Minister, in a speech on 28 December 1963 as one of five steps to peace. The first of these steps, and the one Dobrosielski discussed, calls for "an effectively controlled 'freeze' of nuclear armaments in Central Europe". The "new initiative", as Dobrosielski termed it, envisages a "freeze" on nuclear arms in Czechoslovakia, Poland and the two Germanys. The "freeze" would be restricted to the land. This gets the Poles around the sensitive issue of the multilateral force, to which they are opposed.

A major concern of the symposium participants was that they are failing to get the disarmament message across to the public. The fact that this is so was borne out by a report given by D. Lincoln Harter of Wagner College, Staten Island, N.Y., who found that: "a pilot public opinion poll . . . proves that the average well-educated American has little knowledge and considerably confused opinions on arms control."

Unintentional duplication of research

A survey revealing instances of belated discovery of information in the literature leads to an estimate of what duplication costs

by John Martyn, *Aslib Research Department*

In a letter in *New Scientist* (Vol. 19, p. 148) the rate of duplication of research among scientists was said to have been estimated at about 10 per cent. The first systematic attempt to assess the size of this problem, carried out by the Aslib Research Department, suggests the actual figure is more than double this, and the consequent cost to the nation to be measurable in millions of pounds.

We put questions to 647 scientists engaged in industrial, academic or government research, including chemists, physicists, biologists, psychologists and mathematicians. One question was: "Have you, during your current research, discovered in the literature information which you wish you had had at the beginning of your project?" To this, 144 of them (22 per cent) replied that they had. Many had made more than one such find, so that the total number of instances was 245.

The scientists indicated the relative importance of these finds by placing each in one of four categories, and their answers are summarised in Table 1. Duplication or waste of work on the scale shown there cannot be ignored.

The first category, of simple duplication, is quite obviously important. Moreover, it seems unlikely that the losses or inconvenience represented by the last three categories were regarded by the scientists concerned as unimportant, since the respondents were usually able to identify their finds by an exact literature reference and in every instance, when asked how the information was discovered, they remembered.

Here we have the useful information that was discovered in the end, but discovered too late. For this sample, it represents an ascertained minimum loss. We can be confident that further useful information which had been missed earlier remained to be discovered, though we cannot measure this "iceberg".

The dimensions of the known loss are sufficient to cause concern and justify an attempt to assign a cash value to it, or at least to determine the order of magnitude of the loss. We cannot estimate the cash loss associated with the need for changes in the plan of research (second and third groups in the table) so we must concentrate our attention on the first and last. There were 88 projects (not instances) in these two groups—14 per cent of the total of 647 projects. Some sort of cash loss (scientists' time, in this context, is money) can be inferred to have taken place in at least 14 per cent of all the projects, because of a failure to find published information sooner. However, not all of this information could in fact have been obtained in published form in time to be useful, because it was found that about one-third of it had not actually been published when the project started, although some of it was awaiting publication. Consequently losses due to avoidable late discovery of published information are associated with only about 9 per cent of the projects (two-thirds of 14 per cent).

We cannot translate this figure directly into cash terms, but by making some reasonable assumptions we can arrive at a rough estimate. A modest assumption is that 10 per cent of the funds allocated to the projects mentioned might have been saved had the relevant information been found earlier. It may be a high estimate in some of the cases where "time, money or work could have been saved", but it is almost certainly too low in the cases where duplication, partial or complete, is reported. It seems a conservative guess, therefore, that 0.9 per cent (10 per cent of 9 per cent) of the money spent on these researches could have been saved if all the published information which was ultimately discovered had been discovered in time.

The information found	Number of instances reported
—revealed that their research unintentionally duplicated other work	43
—would, if previously known, have caused them to plan their whole research differently	36
—did, in practice, cause an alteration in the plan of research	60
—would, if previously known, have saved time, money or research work	106
	245

TABLE 1. *Information found "too late" by research scientists.*

In 1962 the expenditure on research and development in the United Kingdom was about £640 million. Results derived from the sample, if applied to this total, give a figure of about £6 million (0.9 per cent of £640 million) and this is the minimum amount we estimate to have been spent unnecessarily because the published information was not discovered earlier. Assuming that the average total cost of maintaining one research scientist, with his supporting services, is £8000 annually, this loss is equivalent to paying about 750 scientists to do nothing. (It is worth considering whether half this number, if employed as information scientists, or technical librarians, could not have reduced the loss to a much smaller amount).

These estimates are, admittedly, crude, but they are based on ascertained facts. There are grounds for believing that they are too low. Firstly, they contain no allowance for those instances of finding information which changed the course of a project, or would have changed it had it been found possible—the second and third groups in Table 1. These may well have entailed financial loss of some kind—and they apply to 8 per cent of all projects. Secondly, the figures relate only to information which was actually discovered; almost certainly there also exist items of useful information or evidence of duplication which were not discovered, entailing further loss. Thirdly, we have assumed that only 10 per cent of the cost is wasted when research is duplicated. It can be, and in some cases is known to have been, nearer to 100 per cent. The true figure for annual avoidable losses could easily be double the estimate of £6 million.

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Life in an ancient desert

To the Namib of southern Africa, the east wind brings food and the west wind brings moisture, but otherwise the animals and plants rely on remarkable adaptations to survive there—adaptations that belie some of the conclusions that biologists have drawn from life in younger deserts

by Dr V. F. M. FitzSimons

In southern Africa we have what is generally considered to be one of the oldest true deserts in the world. The Namib desert, estimated to be at least a million years old and probably much older, stretches along the western coast of the continent. It includes the notorious Skeleton Coast, and extends from the Orange River in the south, northwards throughout South West Africa and into Angola to just south of Mossamedes—a total distance of close on 1000 miles. Its width, from the coast inland, varies from 80 to 100 miles—and along its eastern (or inland) edge gives way to the rugged escarpment of the pro-Namib, which forms the intermediate zone separating the desert proper from the inland highland plateau. In broad terms, this desert may be divided into three distinct types of environment, (a) the areas of large, shifting dunes of red sand; (b) open, flat, gravel-covered plains, broken only by forbidding outcrops of sand-blasted rock; and (c) the normally dry river-beds crossing the desert from the inland highlands to the sea. All those features are visible in the photograph in Figure 1.

In the south, the area of sand-dunes stretches unbroken from the Kuiseb River in the north for close on 400 miles south to the Orange River. These dunes are sometimes as high as 1000 feet; they are composed of fine, red sand and are constantly swept by winds of great velocity. As a result they are always on the move in one direction or another, depending on the prevailing wind, which may blow hot from the east (the "Bergwind") or cool from the south-west. The wind lifts spumes of sand from the crests and causes the dunes to move or creep; the dunes change to such an extent that their use as landmarks is extremely unreliable.

The east wind bears a vast amount of fine, suspended organic matter, chiefly of vegetable origin, that settles on the dunes; in time this detritus finds its way towards the bases of the dunes, where it forms distinct, dark layers. This vegetable detritus apparently forms the basic food supporting the abundant invertebrate life of the desert.

The west wind brings dense fogs or mists from the cold Benguela Current in the Atlantic, usually at night. They reach as far as 40 miles inland, depositing their moisture en route on the desert surface. This deposition of moisture is often so heavy that it has been observed to produce a run-off from sloping rock surfaces and roofs. Rainfall in the Namib is very low and averages little more than 20 to 30 mm. a year. Thus, as far as we know, life in this desert depends on the winds, food being brought in from the east and moisture from the west.

Animal life in the desert ranges from the lowest forms of micro-organisms, living in the sand and vegetable detritus, to a few mammals and birds. Insects predominate, mainly beetles (Coleoptera) and particularly the wingless Tenebrionidae or "Toktokkies". These are present in vast numbers and a great variety of forms (see Figures 2-4), many of which still remain to be described. By their adaptability and specialisation, these beetles have been most successful in establishing themselves in desert areas and have become so resistant to extremes of heat and dryness that they can tolerate conditions fatal to most other forms of life. Adaptations for survival in the Namib desert, whether it be the dunes or open flats, are many and subtle: they include specialised colouring and physical characters. In spite of the extreme heat and dryness that usually prevail during the day, there are many species that are active then. After sunset the desert becomes populated with the

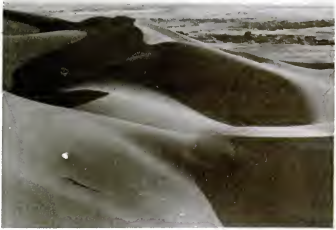

FIGURE 1. *Looking from atop the high sand dunes across the dry Kuiseb River bed to the open plains beyond.* (Figures 1-3, courtesy, L. Schulze)

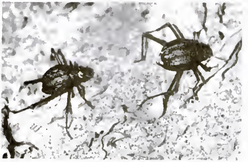

FIGURE 2. *Long-legged black-bodied tenebrionid beetles* (Onymacris sp.). *Female on the right ond male on the left.*

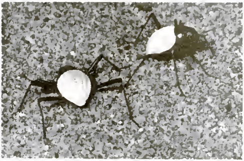

FIGURE 3. *Two long-legged, fast-running white tenebrionid beetles* (Stenocara eburnea).

nocturnal species that have spent the daylight hours sheltering under the sand. Dune-living beetles show adaptations that facilitate digging and make locomotion over the soft, yielding sand surfaces easier. Thus we see special developments of the legs, such as the provision of stiff hairs, spines or even flattening of digits to provide as much resistance as possible so that these creatures can swim over the sand. On the hard, gravelly plains, however, we often find great elongation of the legs, with consequent greater speed and mobility.

It turns out that the Namib Desert, having existed undisturbed for so long and possessing unique climatic conditions, breaks several of the general biological "rules" that apply to life in other deserts.

For example, it is generally accepted that: (a) desert animals acquire a dark colour as a protection against ultra violet radiation from the Sun ; (b) they generally shelter by day and come out at night; (c) they develop legs for digging (fossorial legs); and (d) they develop a large body to reduce the loss of moisture from the surface (transpiration).

In the Namib, on the contrary: (a) colour ranges from black, through browns and yellows to white; (b) the animals that appear by day equal or even outnumber the nocturnal ones; (c) comparatively few species have fossorial legs; and (d) body size is extremely variable, from large to very small, in both diurnal and nocturnal species. Plainly the biology of fauna in the Namib is extremely complicated and presents a wide field for future study.

The most interesting of the new spiders that have recently come to light in the Namib is the "dancing" spider, so called from its habit of dancing round on the tips of its toes in an agitated and aggressive manner when molested. This unique spider, which is uniformly white in colour, has a body length of about an inch and a leg-span of about four inches. It lives in a silk-lined burrow in the dunes during the day, emerging only at night to seek its prey—probably small nocturnal gekkos (lizards), as for the Common Wall Spider, *Palystes natalius*, that occurs in the eastern half of South Africa. Many of the grasshoppers of the Namib are wingless and often so cryptically coloured that they are indistinguishable from the ground they live on unless they betray themselves by movement.

Turning to the vertebrates we have a fair representation of reptiles, mainly lizards of the gekko family, all of which are nocturnal and live below ground during the day. Among these gekkos, the most characteristic is, without doubt, the beautiful Web-footed Gekko (*Palmatogecko rongei*) Figure 5, which is mainly endemic to the sand dunes. Its webbed feet enable this little animal to move with great ease as if on snowshoes over the soft yielding sand. With its beautiful colouring of reddish to orange brown above, lemon yellow on the flanks and pure white below, and its semi-transparent skin, this creature looks almost ethereal or ghost-like when one shines a light on the dunes at night. Other gekkos found thriving in the desert are the Whistling Gekkos (*Ptenopus*) which, towards sunset, emit

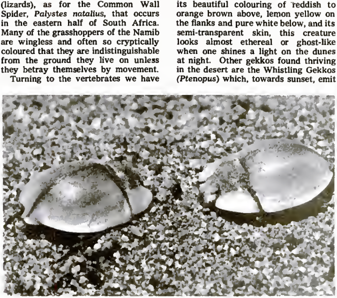

FIGURE 4. *Flottened, disc-shoped, sond-living tenebrionid beetles* (Lepidochora sp.). *The specimen on the left just storting to dig itself into the sond.*

Life in an ancient desert *continued*

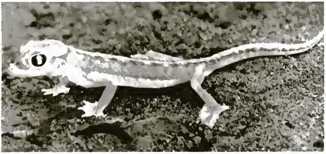

FIGURE 5. *The Web-footed Gekko* (Palmatogecko rangei). (Courtesy, H. Lang)

a shrill piercing call, while squatting at the entrances to their burrows before emerging for their nocturnal activities. In these gekkos the digits are edged with much elongated scales to form a comb-like structure that helps their progress. Another common lizard of the dunes is the "Shovel-snout" *(Aporosaura anchietae)*, an active diurnal lacertid, which has developed a sharp-edged, hollowed-out snout like a shovel to enable it to dive into the soft sand when pursued. Its hind limbs are greatly elongated, and the digits are fringed with long slender scales that enable this lizard to run swiftly over the sand and dig itself away rapidly when it dives to avoid capture. A somewhat similar animal, the Namib Plated Lizard *(Angolosaurus skoogi)*, previously known only from the coastal dune of southern Angola, has recently been found to extend southwards along the coastal dunes, well down the Skeleton Coast.

The snake population consists mainly of a few sand snakes and adders, of which the most characteristic is the Side-winding Adder *(Bitis peringueyi)* shown in Figure 6. This small adder, barely reaching 12 inches in length, is endemic to the desert and has perfected a form of locomotion (similar to that of the Californian Rattler)—by which it can propel itself over loose sand, and even up the windward sides of the dunes, in a series of sideways jerks of its looped body. During the day this adder lies buried in the sand, with the top of its head exposed, keeping a constant look-out for lizards, which may come close enough to be seized and swallowed. It has also been noted that this snake often leaves the end of its tail (usually black) exposed and wriggles it when suitable prey approaches, probably as a lure.

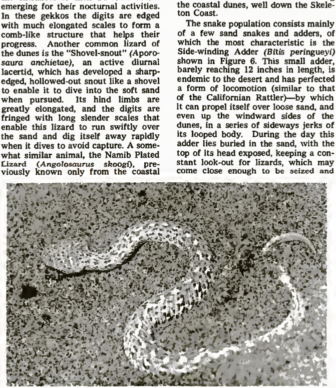

FIGURE 6. *The Namib Side-winding Adder* (Bitis peringueyi) *partially* buried *in sand.* (Courtesy, W. Haacke)

There are few resident birds in the Namib, though certain larks are an exception. They have developed a colour plumage in conformity with their desert surroundings. One case of nesting and presumably breeding in an abandoned Gerbille hole underground has been found, suggesting that even these birds resort to underground cover to survive in the desert.

Among the mammals, the first two complete specimens of a golden mole, almost certainly the form described by Niethammer (1959) as *Eremotalpa granti namibensis* from skull remains found in owl pellets, have now been found and a full description of this rare little creature (which, in fact, is coloured silvery grey) and of its habits will shortly be published. Also occurring in the desert are a number of small rodents *(Gerbillus, Petromys, Rhabdomys, Aethomys* species, etc.), confined for the most part to the open plains, where there are also a number of small carnivores *(Cynictis, Suricata* and *Xerus* species). Hyaena and jackals are sometimes encountered, but can be regarded as intrusive wanderers rather than as part of the resident population.

Vegetation in the true desert is very sparse and in the main dune area is nonexistent, except for a few grasses and compositae which rapidly flower and seed in the valleys between the dunes when rain unexpectedly falls. Along the dry river-beds there is often quite a luxurious vegetation cover, including *Aristida* grasses, shrubs such as Tamarisk *(Tamarix austri-africa)* and even large trees of the Acacia group *(A. giraffae* and *albida)*. On the dune slopes of the river beds we also find large clumps of the leafless "Narras" *(Acanthosicyos horrida)*, Figure 7, which bears a round, melon-like fruit much in demand by the graceful Oryx antelope or Gemsbok, which penetrate deep into the desert when the fruit ripen.

On the open plains vegetation is scanty but here that remarkable "prehistoric" plant *Welwitschia bainesii* occurs. It is endemic to this area of the Namib and an example appears in Figure 8. These plants, distantly related to the Conifers, are deep rooted and have a tough woody stem from the edges of which extend long, hard, green leaves like straps, which grow continuously throughout the life of the plant and stretch for a considerable distance over the ground from the parent plant. These isolated plants are mono-sexual, the male plants bearing small cone-like fruit while the female fruit is considerably larger. They provide good cover for a wide variety of small life, seeking the shelter of their spreading leaves from the extremes of the desert climate.

Along the vegetation-supporting river bed of the Kuiseb River live family groups of people known locally as "Topnaar Hottentots", who to this day occupy temporary, ramshackle huts built of wood and branches. They are not cultivators, but run small flocks of goats and a few scrub cattle that are rapidly denuding the vegetation cover of the river bed. In addition, they burn the wood of the large acacias to produce a kind of charcoal, which is taken in on donkey-back to the nearest town, Walvis Bay, where it is in demand and can be sold or bartered for meal, sugar, coffee and other items. A good return is also obtained from the seeds of the Narras, which sell readily enough as a substitute for almonds.

The scope for research in the Namib is very great, not only in the field of natural history, but also in studies of meteorology, geology, soil structure, underground water resources and other physical phenomena. To assist such work a well-equipped research station (Figure 9) has been built in the desert, on the north bank of the Kuiseb River at a place called Gobabeb, some 70 miles south-east of Walvis Bay and 40 miles directly inland from the coast. Here facilities for comfortable living and for research have been provided to enable scientists to work on the spot for long periods without interruption.

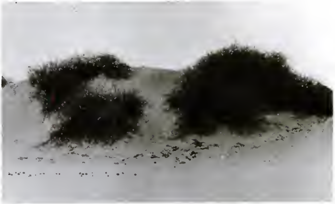

FIGURE 7. *Narras* (Acanthosicyos horrida). *A thorny, leafless shrub of the Namib, which bears round melon-like fruit.* (Courtesy, W. Giess)

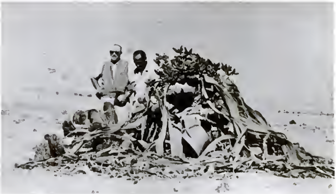

FIGURE 8. *A giant specimen of the 'prehistoric' plant* (Welwitschia bainesii) *found only in the Namib and immediate environs.* (Courtesy, W. Giess)

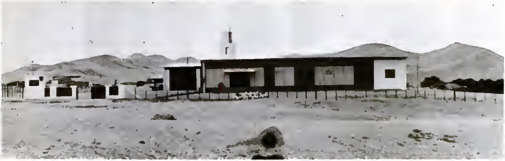

FIGURE 9. *The Namib Desert Research Station with towering dunes of red sand in the background.*

Any scientist interested in making use of the research station in the Namib, which is controlled by a non-profit-making company, should write for details to the Honorary Secretary, Namib Desert Research Association, P.O. Box 413, Pretoria, South Africa.

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Shaving mirror that will not steam up

A mirror that is shatter-proof and extremely light has been conceived by the British Aircraft Corporation and is now being developed by Ward, Brooke and Company of High Wycombe, Buckinghamshire. It uses polyester foil only 0.0005 in. thick, coated with a vacuum-evaporated film of aluminium. Its plywood or moulded plastic backing-board, across which the mirror is stretched, has raised edges that space the taut foil about 1/16 in. away, and a small hole to ventilate the air space behind. The thinness of the reflective material prevents condensation, as it instantly assumes the temperature of warm, humid air, while the absence of glass gives a crisp image with no sign of distortion or chromatic aberrations.

The low weight of the mirror, approximately a fifth of that of a comparable glass one, makes it most acceptable for use in aircraft, where every ounce counts. As a car interior mirror its lightness would prevent annoying vibration without the need for a robust mounting, and there would be no risk of dangerous splintering in the event of an accident. Other applications are far-reaching, from space research and medicine to television studios and architecture. The aluminised side of the foil is mounted inwards to protect it from damage, exposing only the tough plastic film which can be freely wiped to remove finger marks.

Electric sparks to light the gas

A NEW PIECE of equipment, at present being fitted to gas-fired furnaces and other industrial heating systems to allow whole batteries of gas burners to be lit simultaneously, has been developed in the Midlands Research Station of the Gas Council, Solihull, Warwickshire. It provides a motor car ignition coil for each individual burner and relies on the discharge from an electrical capacitor for the lighting. The question of lighting is an important one, since some systems may have 100 burners, and this method is thought to be cheaper as well as more efficient than existing processes.

In many plants the lighting is done at present by employing a transformer to supply high-tension voltage from the mains to a sparking plug at each burner. This system involves the use of a distributor and heavily insulated cables. The new idea relies on a central power unit which, on the throwing of a single switch, enables the capacitor to discharge simultaneously into the primary winding of every coil. The apparatus is being obtained from the motor industry and assembled as required for industrial use by the staff of the various gas boards.

It is serving well, not only in batteries of many burners but also where unusually big burners are in use. The idea is expected to spread, too; users are able, if they wish, to buy their own equipment and fit it themselves. Those who decide to do so can count on advice from gas board staff.

Growing crops on ashes

SEVERAL MILLION tons of pulverised fuel ash are produced in Britain every year as waste material by modern power stations. One way to dispose of the ash is to use it for levelling tracts of country despoiled by opencast mining or similar industrial activities. But before this reclaimed land can be used for farming, a top cover of soil must be added to support crop growth. Since soil is a valuable commodity, and heavy stuff to move, it is important to know the minimum depth required for satisfactory restoration. To augment existing data, which are somewhat sparse, some research has been carried out at Skelton Grange Power Station by members of Leeds University's department of agriculture, on an experimental site prepared on unweathered, water-deposited ash.

They found that to obtain acceptable yields of the arable crops used in the test—kale, barley, oats, rape and potatoes—the minimum requirements even where there was no shortage of soil moisture were a 12-inch cover of soil fortified with 50 per cent more fertiliser than is normally used in farm practice (*Journal of Agricultural Science*, Vol. 61, p. 299). This depth of soil was necessary to minimise the adverse effects of toxic elements in the ash. It should be sufficient to ensure adequate rooting and provide some protection against drought.

One of the aims of the experiment was to determine the extent to which fertiliser could be substituted for soil in reclaiming ash-covered sites. Crop yields fell as soil depth was decreased from two feet to three inches despite the use of extra fertiliser, so replacing soil entirely by fertiliser does not seem feasible, even for crops comparatively tolerant to ash toxicity—unless the chemical and physical properties of the ash were modified so as to provide more favourable conditions.

In brief . . .

AN AMMONIUM compound, CCC, that acts as a plant growth retardant might prove useful for inhibiting the formation of runners in fruiting crops of strawberries. In laboratory tests with pot-grown strawberry plants at the Scottish Horticultural Research Institute, Mylnefield, Dundee, runner formation was prevented by small doses of CCC either sprayed on to the plants or mixed into the soil. After the retarding effect of the chemical was exhausted, treated plants grew more vigorously than untreated ones.

Science in British Industry *continued*

Silicon nitride begins to attract the engineer

One of the latest high-grade ceramic materials to be offered for the consideration of designers and engineers is silicon nitride, a substance with a future at temperatures nearing 1750°C. Now there is news that the Admiralty has placed a contract for a rotary internal combustion engine to be built of it.

A hot-wire anemometer (dismantled) used to measure gas velocities in a nuclear reactor. It is made entirely from reaction-sintered silicon nitride, a material that is now being applied to engine design.

Silicon nitride is a substance that is as hard as tungsten carbide, but which possesses superior properties in many respects. For example, it is highly resistant to chemical attack, particularly by a number of molten metals; it shows up very well in thermal shock tests; it retains a high electrical resistivity at temperatures above 1100°C—and hence is a good high-temperature insulator; and it is resistant to oxidation and to thermal dissociation up to quite high temperatures, approaching 1750°C (see, for example, the photograph). What is more, its mechanical strength appears to increase with the temperature.

Silicon nitride and the technique of making it were first developed by Norman L. Parr and his colleagues at the Admiralty Materials Laboratory, near Poole, Dorset, and by P. Popper at the British Ceramics Research Association, Stoke-on-Trent. The Admiralty work was embodied in patents taken out by the National Research Development Corporation. Doulton, a leading industrial ceramics firm, has licensed the process from NRDC for industrial development.

In the process used by Doulton, silicon powder of carefully graded size distribution is formed by pressure into the roughly dimensioned final shape by extrusion, pressing or casting. The roughly-shaped article is then heated to about 1100°C in an atmosphere of nitrogen, until about 5 per cent of the silicon has been converted to silicon nitride. Care has to be taken to control the heat output from the strongly exothermic nitriding reaction; otherwise the temperature would rise to a level at which sintering could take place to seal the pores and deny access to nitrogen in the second stage of the process.

The mechanical properties of the partly nitrided article allow it to be machined to shape—using normal metal-cutting techniques—with the dimensions adjusted to allow for the small increase (0.0015 in. per inch of diameter) that will take place when the article is finally fully nitrided. The final process to produce fully nitrided articles is heat-treatment in nitrogen at temperatures rising from 1100° to 1400°C until the full "stoichiometric" weight of nitrogen has been taken up to correspond to the formation of Si_3N_4. The process is such that high precision can be maintained without further machining. If still smaller tolerances have to be met, the fully nitrided article can be machined using diamond tipped tools.

The product will contain two slightly different types of crystal; it will have a bulk density of about 2.5 (about 80 per cent of the theoretical maximum) and will therefore be somewhat porous, although the true permeability is very low.

The high resistance of this "reaction-sintered" silicon nitride to attack by molten metals such as aluminium, lead, tin and zinc at temperatures up to 1000°C (though copper at 1150° attacks the ceramic fiercely) means that it can be used to make long-life crucibles pouring spouts, tubes and conduits for handling these metals in the molten state. Additionally, the components will not contaminate the metal. This high resistance to attack, coupled with the dimensional accuracy with which components can be made and the physical strength of the material, means that it is possible to make economically long-life pumps for pure molten metals. Important applications have been found in nuclear reactors for both its electrical and mechanical properties.

Another outstanding property of the material is its resistance to thermal shock. Test specimens of silicon nitride have been subjected to the thermal shock test cycle and have come through triumphantly without failing when specimens of other so-called thermal shock resistant substances have failed within the first few cycles.

For certain applications, a non-porous form of the ceramic is desirable, and research by Plessey has led to a suitable process, in which silicon powder is first combined with nitrogen to change it completely into Si_3N_4. This powder is then thoroughly mixed with up to 5 per cent by weight of magnesium oxide and "hot-pressed" in a graphite die to the required shape at about 1800°C and 1.5 tons per square inch. By allowing in design for the small change in dimensions that follow heat-treatment, accurately sized products can be produced. Higher accuracies can be achieved by subsequently turning the products using diamond tipped tools.

This material has a bend strength approaching 100 000 psi at normal temperatures, and 70 000 psi at 1200°C—several times the value of the reaction-sintered form.

Incidentally, a by-product of work on silicon nitride has been the observation of methods for making silicon nitride whiskers, materials of considerable potential interest for improving the hot strength of metals such as aluminium (see "Science in British Industry", 8 August 1963).

Here, then, is a material of considerable interest to engineering designers. The announcement that BSA is to develop a Wankel rotary engine built from silicon nitride may be the forerunner of many examples of its application to engine design. Another, already mooted, is the development of a ceramic inward-flow radial turbine.

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Science in Overseas Industry

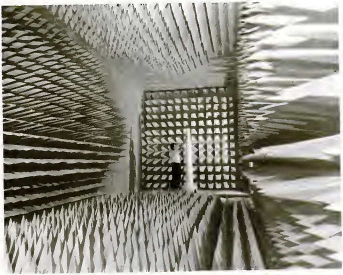
UNITED STATES Sound "paints" pictures of the seabed

AN ULTRASONIC camera for mapping the seabed at a rate of 1.5 square miles an hour has been developed for the Office of Naval Research. Capable of resolving an object only 30 in. by 4 ft at a depth of 20 000 ft, it was used in the recent (abortive) search for the submarine *Thresher*.

This apparatus continuously scans the seabed with a fan-shaped beam of high-frequency ultrasound, in strips 2400 ft long and 4 ft wide, and records the topographical details—hills, plains, valleys and sunken objects—on a roll of sensitised paper; at the same time the view is displayed on a television screen. The camera is towed just above the seabed, at a height of 200-400 ft, and a speed of up to 4 knots. It was developed through collaboration between two Westinghouse laboratories, the Research Laboratories at Pittsburgh and the Defense and Space Center at Baltimore.

Sonar techniques became established during the second World War as the best means of detecting objects under water, but such systems have not previously had the combination of high resolution and mobility to enable them to "paint" a picture of the seabed. The Westinghouse researchers believe they can now design a system to any specification of resolution and range, an assertion that should be most attractive to the geologist, the oceanographer and anyone interested in claiming minerals from the bed of the ocean.

Plastic foam simulates the "silence" of space



IN THIS CHAMBER, with its "contemporary" decor of long, thin spikes, radar signals will be absorbed almost as completely as they are lost in outer space. Its high capacity for absorbing energy is achieved by lining the walls with over 2500 foamed plastic spikes. In this laboratory, engineers at Sperry Gyroscope Company, Great Neck, New York, will study the sensitivity of their radar equipment to missiles in space. The photograph shows a research worker mounting an experimental radar target on a polystyrene pedestal which, like the rest of the chamber, is nearly invisible to radar.

FRANCE

A computer to watch the kilowatts

THE INITIAL STEP towards the fully-closed-loop control of a power station has been taken by Electricite de France at St Ouen. Four 250-megawatt sets will eventually be in operation, though one only has been installed so far. This set uses the computer simply to give a "print-out" of economic balance at regular intervals, and to actuate alarm signals if any of the parameters being measured go outside predetermined upper and lower limits.

The system takes as its starting point the amount of heat required per kilowatt-hour, assuming optimum operating conditions for the whole plant. In practice, there are a number of factors which reduce the plant's efficiency. The deviation from optimum can be divided into two categories, external and internal: the external factors include the outside air temperature and preset load programme, and the internal ones cover most of the plant operating factors such as fouling of boilers and heaters, and water and steam leaks.

Altogether, 600 inputs are fed to computer store, and these are sequentially scanned every ten seconds. Real-time deviations are calculated and stored, the internal deviation also being indicated on the control panel, thus enabling corrections to be made. An economic balance is calculated and printed out every 30 minutes, based on the average input figures over the previous 30-minute period.

CANADA

Radiation stunts the fruit trees

UNTIL RECENTLY, the only practical method of regulating the size of a fruit tree has been to graft the scion (which eventually forms the visible part of the tree) on to dwarfing rootstock. During the past decade, naturally slow-growing mutants of a number of apple varieties have been discovered that form compact, spur-type trees on their own roots. This observation prompted scientists at the Canadian Department of Agriculture's Summerland Research Station to see whether mutants with the same useful growth habit could be produced artificially by irradiation. Dormant scions of several varieties of apple and cherry (for which no dwarfing rootstocks are known) were exposed to X-rays, gamma rays or thermal neutrons. Then they were grafted on to established trees and allowed to grow to the fruiting stage.

Many types of dwarfing resulted, mostly of no practical value, but three varieties of apple—McIntosh, Spartan and Yellow Transparent—and one cherry, Lambert, yielded types that combined normal fruit characteristics with the desired compact shape and slow growth. If these new dwarfs continue to behave well in more extensive test plantings to be carried out this year, propagating material from some of them will be available to fruit growers in 1965. Ordinarily they will be grown as seedling rootstocks; if still smaller trees are required, dwarf scions can be grafted on to dwarfing rootstocks.

Since the trend in fruit growing is strongly towards orchards closely planted with small trees—an arrangement that simplifies pruning and fruit picking—these new man-made mutants will be a welcome addition to the existing range of naturally occurring spur-type mutants.

USSR

"Black box" that finds faults in farm machinery

THE FIRST conference in the Soviet Union on the role of cybernetics in agriculture was held recently by the Siberian branch of the All-Union Research Institute for the Mechanisation of the Rural Economy, according to *Nauchno-Tekhnicheskie Obshchestva*, November, 1963. In fact, the meeting might well have been called "how logic circuits can be used to diagnose faults in agricultural machinery".

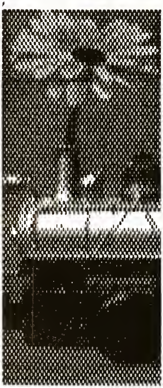
The ever-increasing complexity of agricultural machines makes it harder to locate faults without returning the machine to a maintenance centre (which could be an expensive procedure in some parts of the USSR). Thus any help is welcome. One approach was illustrated by a device applicable to the hydraulic system of a tractor or combine. It consists of a box about the size and shape of a small suitcase containing a panel of 30 switches. The mechanic or driver feeds the symptoms of his apparently sick machine into the box by answering a series of questions linked to the positions of the switches. The information set up on the switches is then sifted by electrical logic circuits within the box and an opinion given as to the state of the hydraulic system.

This approach might be termed a "mechanised fault-finding chart", for the operator observes the symptoms and leaves diagnosis to the "black box".

Another device demonstrated at the conference embodies the opposite approach, in which a "cybernetic device" observes the symptoms, converts them into a more easily understood form and then presents the mechanic with information enabling him to trace the fault himself. This device picks up the noise and vibration developed by the engine and transmission system of a tractor and plots a correlation curve, from which the operator can tell immediately whether there is a fault in the drive or not; by more careful examination he can obtain a good idea of the nature of the fault.

UNITED STATES

Electrostatic printing challenges the poster artist



Photograph (to scale) shows detail of an electrostatically-printed poster.

WHEN A SINGLE advertisement measuring perhaps 30 by 90 ft is needed for some special purpose it is normally hand-painted, since the lithographic printing technique used to produce such advertisements in quantity becomes expensive for a "one-off" job. Hand painting, however, is also somewhat costly, and the time involved renders this form of advertising slower than other media such as television and newspapers. An American outdoor advertising company, Metromedia, asked the Stanford Research Institute, Menlo Park, California, to study this problem, and a team led by Albert Macovski devised a process that is not only faster but achieves a better quality than that is usually obtained by lithography (*Research for Industry*, Vol. 15, No. 6).

The starting point of the process is the artist's design, which can be any type of art work and any of a range of convenient sizes. This design is scanned by photoelectric cells line by line, once for each of the colours used in the system of reproduction, say yellow, magenta and blue, in a three-colour system.

The signal obtained from the photocells is fed to a "charge deposition" stylus. This stylus physically scans the surface to be printed, which is backed by a conductive plate, with the result that rectangular areas of electrostatic charge appear on the surface, of constant height—that of the scanning line—varying in width according to the intensity of the colour concerned on the original design. Charged powder of the same colour is dusted on, and the surface is heated to fix it.

The number of lines to the inch is chosen according to the money and time available. An advertisement 12 by 25 ft, with a resolution of 20 lines an inch—twice that of normal lithography for the purpose—can be prepared in 90 minutes. In one experiment, Macovski achieved a resolution of 120 lines an inch. The new process may, he thinks, find other applications in colour or monochrome reproduction.

In brief . . .

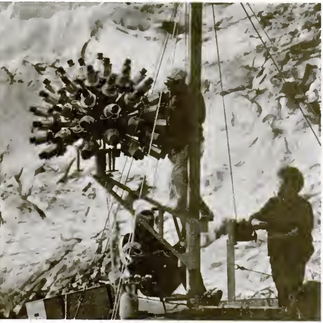
THE SPEED OF a bullet in a rifle barrel could be measured cheaply and quickly by a gamma-radiation technique, suggests G. L. Gyorey of Michigan University. A number of radiation sources would be ranged along one side of the barrel, with an equal number of detectors facing them on the other side. The instant when the bullet passes between any source and its detector could be recorded to within a few micro-seconds; hence not only the average speed but the way it varies along the barrel could be found.

* * *

SEDGES ARE not easy to identify when flowering or fruiting, and are even more difficult to recognise when in the vegetative stage. To help those whose job requires them to perform the latter task, A. W. H. Damman of the Canadian Department of Forestry's Research Branch has produced a new key (Publication No. 1017) on which vegetative characteristics are used to differentiate 70 species of Carex native to the forests, barrens and bogs of Newfoundland.

Science in Overseas Industry *continued*

SWITZERLAND Camera that looks like a hedgehog



There are 57 lenses in this remarkable camera, which is now touring Switzerland taking 360-degree panoramic photographs in colour. These photographs will be displayed in the Holiday Pavilion at the Swiss National Exhibition in Lausanne this summer, on a dome-shaped screen which completely envelopes its audience. The dome will be 60 ft across, and 57 projectors will simultaneously display the slide from the corresponding camera on a hexagon some 15 square yards in area. A fully-automatic remote control system allows all slides to be changed at once, or individual groups of slides to be screened in sequence. The camera and projectors were developed by a Zurich company, Ganz and Company.

CANADA Thinning the forest with greater precision

IN FORESTRY practice thinning operations have for many years been conducted on the basis of widely-recognised empirical grades, that range from a very light thinning where only the standing dead and dying trees are removed, to the sixth, most drastic grade, which leaves behind only a stated proportion of the dominant trees. These thinning grades, and other indices that express the number of trees or volume of wood to be removed as a percentage of the original stand, are valueless for scientific studies; the results achieved are relative, and depend on the initial density of the stand. But several objective methods for calculating thinning schedules have recently been proposed in Germany, the Netherlands, Norway, Britain, and North America.

How these numerical guides will work in practice has not yet been determined, but clearly they merit close attention, for often thinning is the only means at the forester's disposal for shaping his forests.

A critical assessment of these new techniques by P. E. Vezina of Canada's Forest Research Laboratory, Sillery, Quebec, suggests that development of the statistical approach to the problem of regulating stand density, based on equations derived from the observed relationship between growth and various stand factors, may well lead to a better understanding of the two basic aspects of commercial forestry: the biological phenomena that regulate stand density, and the economic criteria that govern the value of the wood produced.

UNITED STATES

Precious metals help tungsten to sinter

RESEARCH at the Massachusetts Institute of Technology and elsewhere has shown that low-porosity components of tungsten can be obtained very rapidly, within as little as 30 minutes, at temperatures well below the melting point of the metal, simply by adding small amounts of palladium, nickel, rhodium, platinum or ruthenium to the tungsten powder before sintering. Just why this is so has occasioned much debate in metallurgical circles. H. W. Hayden and J. H. Brophy, of the metallurgical department in MIT, believe they have the answer—and have shown which of the "activating" elements gives the best results. It proved to be palladium (*J. Electrochem. Soc.*, Vol. 110, p. 805).

The researchers dissolved small amounts of one or other of the compounds of the metals in water, then mixed this solution with finely-powdered tungsten. The metallic "sludge" was left overnight at 150°C for excess moisture to evaporate, then reduced at 800°C for an hour in an atmosphere of hydrogen. Small, rectangular samples of the material were pressed at 26 000 psi, weighed and measured, and then fully sintered in an atmosphere of hydrogen at various temperatures from 850° to 1100°C, for periods of from 30 minutes to 16 hours. Afterwards the samples were cooled and weighed and measured again.

The experimenters found that palladium gives the greatest speed combined with final density; when this element is added and the compressed powders are sintered at 1100°C, for example, their density reaches 93.5 per cent of the theoretical maximum within half an hour. It takes 16 hours to reach what, most probably, must be regarded as the maximum possible density, 99.5 per cent. Without the addition of an activating element, tungsten only begins to sinter at 1100°C.

From observations made during these experiments, in which the kinetics of the process were carefully considered, and from previous data, Hayden and Brophy conclude that the "activating" element forms a very thin layer on the surface of each particle of tungsten. At points where the particles touch one another atoms of tungsten dissolve in this layer. Tungsten atoms diffuse along the layer, away from the point of contact, allowing the particles to pack together more tightly.

The three points of practical significance are that it happens at a temperature below the fusion point of any of the alloy systems involved, that it happens quickly, and that only small amounts of the "activating" elements are required.

Genetic weapons in insect control

Population replacement, induced sterility, or the introduction of deleterious genes—all are promising biological methods of fighting disease-carrying insects

by Peter Collins

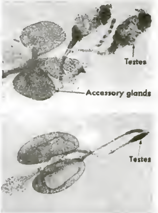
ONE result of the urgent need to find alternatives to the use of dangerous chemicals in the control of insect pests has been a great revival of interest in biological control. Although usually regarded as a method of employing predators or parasites against pest species, biological control embraces all biological approaches to the problem. One such approach, which is chemical in the sense that chemicals may be employed indirectly, was discussed recently by Dr R. H. Wright when he considered the use of sex attractants to lure insects to their own destruction (see *New Scientist*, 5 December). Another, more purely biological approach is that now being considered under the term "genetic" or "autocidal" control.

In a recent review of the control of disease-transmitting insects (vectors) published by the World Health Organisation, Dr G. B. Craig of Notre Dame University, Indiana, has discussed three promising methods of tackling the problem. They are population replacement; induced sterility; and the spreading of self-propagating deleterious genes. The first of these is based upon the idea that, as an ecological niche is left vacant when a pest species is controlled, it should be filled by the deliberate introduction of a non-pest species with basically similar ecological requirements. Craig has neatly summed this up as "immunising the environment", and he quotes the way in which, as the mosquito *Anopheles labranchiae* was eliminated during malaria eradication campaigns in Sardinia, its place was taken by the relatively harmless but closely allied species, *A. hispaniola*.

As a variant on this theme, it might be possible to introduce strains within disease-carrying species which do not carry the parasite concerned. Strains of mosquito species which are refractory to the malaria parasite are known to exist and might replace the vector strains without even reducing the mosquito population, and thus enable the use of insecticides to be avoided, or at least reduced to a minimum.

Induced sterility in insect pests is not, of course, completely new, for it is the principle of the well-known operation by which the screw-worm fly (*Cochliomyia*) was eradicated from the island of Curacao and parts of the USA. In this instance, however, irradiation was used to produce the sterile males with which the natural population was swamped. As a development of this idea, Dr E. F. Knipling, of the US Department of Agriculture, has suggested the possibility of controlling tsetse flies. For a number of reasons, however, he considers that chemical sterilisers rather than irradiation should be used, and he has indicated that such a system might well be competitive in cost with chemical control even in areas with a high density of flies per square mile. As the natural density decreased, release of chemically sterilised males would become progressively more economical, as compared with methods at present employed.

It has been pointed out recently that both irradiation and chemosterilisation may reduce the vigour and mating effectiveness of the male insects. If, however, naturally occurring sterile strains could be discovered and used, this might be avoided. A number of such "sterility mechanisms" have been listed by Craig for various insects, including such notorious disease-transmitters as *Anopheles gambiae*, *Culex fatigans* and *Aedes scutellaris*. Work on the first of these has been done by Dr G. Davidson and his colleagues at the Ross Institute in London. He found that when he crossed strains of this species, respectively resistant and susceptible to insecticide, the males in the next generation were sterile, although the females were fertile. Far from being less efficient, however, the sterile males showed "hybrid vigour" and improved mating performance. When these males were introduced into breeding cages containing various proportions of normal males and females, the successful fertilisation rate of the females dropped, and if the normal males were "swamped" with sterile individuals in the ratio of ten to one to one female almost all of the resulting eggs were sterile.



Reproductive systems of the normal male Anopheles gambiae *and the hybrid. (Courtesy Mr G. F. Mason, Ross Institute of Tropical Hygiene, London.)*

From this second "autocidal" system to the next is a comparatively short step. For example, it has been found that if strains of *Anopheles gambiae* which live in fresh water are crossed with those whose larvae live in salt water, a generation consisting solely of males may result. This is thought to be due to a "daughterless gene". In other insects, such as the fruit fly *Drosophila*, it has already been shown that "daughterless" genes may spread rapidly through an entire population. This is the principle known as "meiotic drive", which Craig has summed up by pointing out that "a locus or a chromosome which exhibits meiotic drive has an advantage because it is present disproportionately often in the reproductive cells (gametes) contributed to each generation. Such a factor will tend to increase in a population, even when it may in the end result in the extinction of the species. As might be expected, what have been termed "protective mechanisms" may develop within the species, but nonetheless, it might be possible to cause extinction before this can happen.

It is evident that before any of these three approaches to autocidal control can be widely used, a great deal of research will need to be done, and what might be termed "genetic technology" developed.

New looms that streamline weaving

Various methods of feeding a single weft thread through the warp replace the heavy shuttles of conventional looms and eliminate one processing stage. The new machines afford more variety in colour and are much quieter, making weaving sheds more tolerable to work in

by Kurt Greenwood
Shirley Institute, Manchester

IN THE evolution of weaving technology we have reached a stage when even the "establishment" amongst weavers and loom makers is beginning to accept the need for radical change. It is symptomatic that a few months ago, in the Eastern Sector of Berlin, George Hattersleys, the oldest British firm of loom makers, signed a licensing agreement with East Germany to produce a new type of weaving machine—the Textima (Neumann) gripper-shuttle loom. At the recent International Textile Machinery Exhibition at Hanover many old-established manufacturers of conventional looms such as Crompton & Knowles and Draper of the USA, Saurer of Switzerland, Dornier, Guesken and Zangs of Germany and Snoeck of Belgium, exhibited new types of weaving machines.

It is customary to refer to these machines as "shuttleless" looms but nevertheless some of them still use a shuttle. Figure 1 shows the essentials of the new machines. The main feature they have in common is the withdrawal of the weft yarn from a large stationary package which replaces the small package—called the "pirn"—carried by the conventional shuttle. (Both types of yarn package are shown in Figure 2.) This basic change in the nature of the weft supply eliminates one stage in the processing of weft yarn, that is, winding the pirn. To achieve this the designers of pirnless looms had to solve two problems. They were (1) to provide means for inserting the weft into the warp; and (2) to provide the fabric with a satisfactory selvedge (fray-resistant edge).

These problems have been solved in a variety of ways and the nature of the solution, particularly that of inserting the weft, has a profound effect on the production rate of the machine, its versatility in terms of the range of fabrics it can produce, and the amount of noise it makes—always an important factor in weaving mills.

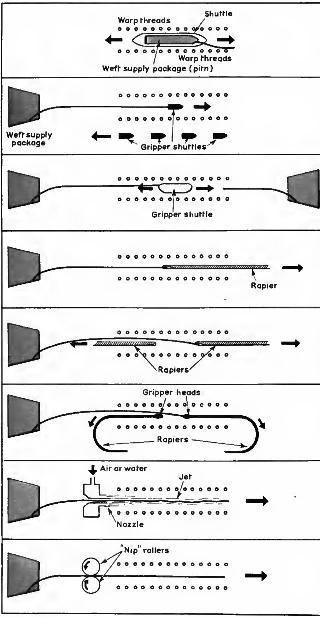
Up to now the Sulzer system of multiple gripper shuttles has found the widest application and there is a growing interest in the various rapier systems. Water-jet looms are being used on a very small scale and air-jet looms have made virtually no headway. Commercial production of the single gripper-shuttle machines has only just started but their prospects are reasonably promising. The "solid-friction" system invented by Vincent has not reached the stage of commercial production but I include it because it represents the outstanding British contribution to pirnless weaving. Other methods of weft insertion are possible, and during a recent visit to the USSR, I saw some interesting development work on two other principles.

A detailed discussion of all the systems shown is not possible but a few general comments are necessary. The idea behind the two types of gripper-shuttle loom is to use a much smaller shuttle than a conventional loom and Figure 2 shows that this has in fact been achieved. However, the smaller shuttles are more easily deflected from their path so both systems require shuttle guides. These are more closely spaced with the small multiple shuttles than with the larger single gripper shuttles. Jet looms and the solid-friction system aim at doing away with all fast-moving mechanical yarn carriers, so to save power. They have been successful to some extent but only at the cost of a poorer control of the yarn, which is sometimes inclined to buckle and get entangled with the warp. These three methods are therefore only suited to a limited range of yarns.

In the jet looms the yarn is accelerated by friction between the fluid and the yarn. Water is a far more efficient medium than air for doing this; for any desired yarn speed the initial velocity of an air jet must be ten times the velocity of a water jet. Both air and water jets disperse fairly quickly after leaving the nozzle—a handicap because it means that the width of these looms is limited.

All the methods mentioned so far entail a very high initial acceleration of the yarn, which then continues to travel at a very nearly constant velocity owing to the inertia of either the shuttle or the fluid or of the yarn itself. The idea behind the rapier looms is to do away with this initial acceleration and to insert the yarn by a positively controlled motion which is approximately a simple harmonic one and involves higher yarn velocities. But there is some question whether the yarn suffers more (in the form of tension and breakage) from high velocity or from high acceleration, a scientific issue at the centre of the controversy about the advantages of rapier looms against the others. Loom makers in either camp have a vested interest in this matter and little information is available from objective sources. Research and practical experience should, however, throw some light on the problem within the next few years.

The virtue of the single rigid rapier is its simplicity. Its vice is that it travels in one direction without "payload". The time required for this journey is wasted and leads to low loom speeds; the double rapiers were introduced in order to overcome this problem. Although each of the two rapiers still has one "wasted" journey, their combined effect is that the yarn itself



Conventional Shuttle. The weft yarn is placed into the shuttle in the form of a small spool (pirn) and is withdrawn from the shuttle as the latter moves to and fro across the warp.

Multiple Gripper Shuttles. Each shuttle is projected at high speed across the warp and carries one weft thread. The shuttles return to their starting point by means of a conveyor belt. (System Sulzer)

Single Gripper Shuttle. The shuttle inserts one weft thread alternately from the left and right hand side of the loom. (System Cleeys, Saurer, Textima-Neumann, Zangs)

Single Rigid Rapier. The rapier (a long thin rod) enters the warp from the right and carries one weft thread across the warp on its return journey. (System Ancet-Fayolle, Iwer)

Double Rigid Rapiers. The two rapiers enter the warp simultaneously and meet in the centre. The left-hand rapier carries the weft thread to the centre of the warp and then hands it over to the right-hand rapier. (System Dornier, Guesken, Societe Alsacienne)

Double Flexible Rapiers. Same principle as with rigid rapiers but the rigid rods are replaced by flexible steel or plastic tapes which follow a curved path. (System Crompton & Knowles, Dewatex, Draper, Engels, Nebiolo, Safog, Snoek, SMIT)

Air or Water Jet. At each weft insertion a pump (not shown) projects a jet of air or water from the nozzle. The yarn lies in the nozzle and is carried across the warp by the jet. (System Elitex-Svaty, Maxbo)

Solid Friction. The yarn is "nipped" between two rollers rotating at high speed. The frictional forces between the rollers and the yarn accelerate the latter and the yarn travels across the warp under its own inertia. (System Vincent)

FIGURE 1. *Various weft insertion systems.*

New looms that streamline weaving *continued*

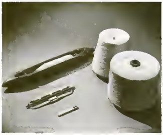


FIGURE 2. Various types of shutties and weft supply packages. *(Top) Conventional Shuttle containing pirn of weft yarn. (Middle) Gripper shuttle of the Textima-Neumann loom. (Bottom) Gripper shuttle of the Sulzer loom. The two gripper shuttles are holding the ends of the weft threads supplied from large packages (cones) of yarn.*

is always in motion. Handing the yarn over from one rapier to the other, however, introduces a potential source of trouble and protagonists of the single rapier emphasise this point. Rigid rapiers, whether single or double, have to be accommodated when they are outside the warp. The consequent waste of floor space gave rise to the idea of the flexible rapier. Figure 3 shows the gripper heads of a flexible rapier loom. It uses less floor space but the control of the rapier movement is less positive.

Thus there are many pros and cons with all the solutions of the weft insertion problem. The same can be said of the various types of selvedges which are shown in Figure 4. The basic requirements of a selvedge are that it should be neat in appearance, be strong enough to withstand the stresses in the weft direction which are often imposed on fabrics during subsequent processing and waste as little weft yarn as possible. The selvedge produced by the conventional loom meets all these requirements and presents no problem. In pirnless looms, however, a problem is caused by the fact that, basically, each individual weft thread is a separate entity. If no precautions were taken the warp threads near the edge of the cloth would not be bound in any way and the fabric would have a frayed appearance. I shall not concern myself here with the methods used to obtain the various types of selvedges except to say that some of the solutions which produce a good result tend to have disadvantages connected with the nature of the selvedge mechanism itself. In appearance the two "tuck-in" selvedges are undoubtedly the best. They differ from each other in that solution *a* (Figure 4) doubles the density of the weft threads in the selvedge compared with the body of the fabric. All other selvedges leave a trimmed fringe of yarn ends along the edge of the fabric which detracts from the appearance of the cloth and invariably entails some yarn wastage during the trimming operation. From the point of view of strength solution d is the best, closely followed by *a*, *e*, and *b*. Solution c is the worst, but the simplest from the point of view of loom design. With fabrics woven from thermoplastic materials the appearance and strength of a "fringed" selvedge can be improved by trimming and heat sealing. Figure 5 shows fabric samples with various types of selvedges.

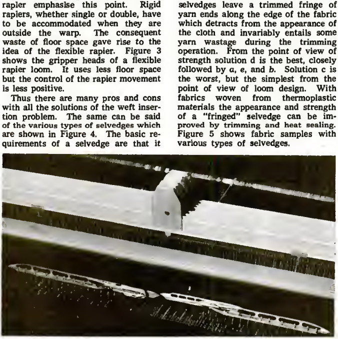
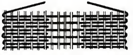


FIGURE 3. Gripper heads of a double flexible rapier loom (Snoeck). *The two gripper heads are fixed at the end of flexible tapes and are about to meet to hand the weft thread over from one to the other.*

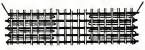
While the elimination of pirn winding is the common feature of all pirnless looms, their performances naturally vary. Loom speeds are expressed in terms of the number of weft threads (picks) inserted per minute (p.p.m.) and they range from 900 p.p.m. on looms weaving ribbons an inch wide down to 25 p.p.m. on wide looms producing papermakers' felts 20 yards across. Obviously one pick represents a greater amount of weft on a broad loom than on a narrow one, so the real measure of the production rate of a loom is the rate of weft insertion (*R*) expressed in yd/min. Simple arithmetic shows that, for the two extreme cases quoted above, *R* has values of 25 and 500 respectively. This tendency for wider looms to have higher production rates in spite of their lower speeds is a basic fact in weaving technology which must be taken into account when comparing different types of looms. The water- and air-jet looms, for instance, are limited to maximum working widths of 42-48 in. and therefore cannot take advantage of the increased production rates obtainable with greater width. On the other hand the Sulzer weaving machine is only produced in widths greater than 85 in. and we may ask to what extent its high production rate is due to its width or to some inherent technical superiority. To obtain a fair comparison between the productive capabilities of different systems the width factor has to be eliminated.

I have analysed the available data for a number of conventional and pirnless looms and have found that the relation between rate of weft insertion (*R*) and working width (*W*) can be fairly accurately expressed by $R = k\sqrt{W}$, where k is a constant for a given type of loom which expresses its inherent productive capability irrespective of width.

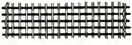
The values of k for different types of looms are given in Table I and are subdivided according to the number of weft colours any particular loom can weave simultaneously. This subdivision is used because with some looms the speed goes down as the number of weft colours goes up. It is claimed that the three machines listed as 8-colour looms do not suffer in this way and therefore one must assume that the k values quoted for them would be the same if they were used with one weft colour only. The table shows that while some new weaving machines have achieved production rates 75-85 per cent higher than those of equivalent conventional looms,



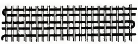
(a) **"Tuck-In" salvedge.** Both ends of each weft thread are "tucked" into the fabric with the following thread.



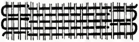
(b) **"Binding Thread" selvadga.** A special thread is woven into the edge of the fabric.



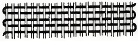
(c) **"Lana" selvedga.** The warp threads at the edge of the fabric are twisted round each other to grip the weft firmly.



(d) **"Hairpin" selvedge.** Pairs of weft threads form a "hairpin" shape facing alternately right and left.



(e) **"Tuck-in" selvedge.** One end of each weft thread is "tucked" into the fabric with the next-but-one weft thread.



(f) **Convantional selvadge.** Consecutive weft threads are joined alternately on the left and right edges of the fabric.

FIGURE 4. Fabric selvedges produced by pirnless looms.

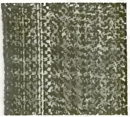
others have rates that are equal only and others still have lower ones. These last machines are not out of the running because high-production machines have certain disadvantages. Firstly, they tend to be expensive. To buy the capacity of inserting 100 yards of weft per minute with a Sulzer machine costs approximately £450; with a conventional loom incorporating pirn winding it costs about £330. (It costs only £250 with a water-jet loom, which is also a high-production machine, but here the range of application is severely limited.) Secondly, the efficiency of high-production machines is greatly affected by yarn breakage rates. Most of the operative's time in a weaving mill is taken up by repairing yarn breaks and, while machine speeds have increased, the time required to knot a broken thread has not diminished. With high-production machines this time becomes increasingly important and a situation can arise which is similar to that in air travel, where the length of the journey is often more dependent on the efficiency of the customs officials than on the speed of the aircraft. High-production machines are essentially suited only to long production runs with low yarn breakage rates.

TABLE I. — Values of k for various types of loom

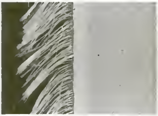
No. of weft colours:	1	4	8
Type of loom:			
Sulzer, multiple gripper shuttle	420	366	—
Elitex, water jet	414	—	—
Saurer, single gripper shuttle	312	—	—
Snoeck, double flexible rapier	—	—	264
Textima, single gripper shuttle	—	—	258
Draper, double flexible rapier	240	—	—
Conventional shuttle loom	234	204	—
Zangs, single gripper shuttle	228	—	—
Iwer, single rigid rapier	—	—	168

k is the constant in the relation $R = k\sqrt{W}$, where *R* is the weft insertion rate in yd/min. and *W* is the fabric width in yd. *k* represents the weft insertion rate which the loom would have if its working width were 1 yd.

The *raison* d'être of all looms is the woven fabric. Weaving technology had, of course, reached a high degree of versatility even before the advent of the power loom, and during this century it has not made a major contribution towards fabric appearance or performance—nor is it likely to do so. The major advances here have been made by the development of new fibres and yarns and new chemical treatments of the woven material. The main contribution of weaving technology itself has been towards high productivity and lowering production costs so that better fabrics came within reach of more people. In general, however, each step towards higher productivity caused some reduction in the versatility of weaving machines and was then followed by an effort to restore it.



"Tuck-in" selvedge of a woollen material woven on the Sulzer Loom.



"Fringed" selvedge of a Nylon fabric woven on the Elitex water jet loom.

Trimmed and heat-sealed selvedge of the above Nylon fabric which has been finished with a printed design.

FIGURE 5. Various solutions of the selvedge problem.

The present change-over to pirnless weaving has followed this pattern. The Sulzer weaving machine at first could not weave continuous filament yarns and could insert only one weft colour. It was some years before a 4-colour model was available and only very recently has it been modified to weave continuous filament yarns, the man-

New looms that streamline weaving *continued*

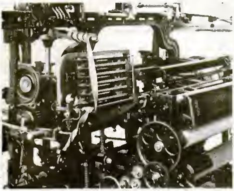


Figure 6. Colour selection mechanism on a conventional loom. *This mechanism caters for six weft colours. Each colour requires a separate shuttle and shuttle box. For the selection of the desired colour, the whole heave box assembly has to be moved vertically so as to bring the appropriate shuttle in line with the warp. This movement must take place between the insertion of consecutive weft threads.*

made fibres that are so important as textile materials. The Textima gripper-shuttle loom is at present suitable for woollen yarns only and it will take two or three years of development work before it can weave worsteds. The Elitex water-jet loom can weave only hydrophobic fibres like nylon and Terylene and there is little prospect of expanding its range of application. There are many other instances of loss of versatility, even if only temporary, caused by the introduction of pirnless weaving.

It is all the more remarkable therefore that in one respect—weft colours—some of the pirnless looms are more versatile than the conventional machines. Figure 6 shows the colour mechanism of a conventional loom designed to weave six colours of weft (there is never any problem about colour patterning in the warp). This rather clumsy system imposes restrictions on loom speeds. Furthermore, if odd numbers of weft threads of any one colour are to be inserted both sides of the loom have to be fitted with an assembly. This in turn makes it difficult to fit an automatic weft replenishment device. In fact most looms with complete freedom of colour sequence are still non-automatic in the sense that weft replenishment has to be carried out by hand.

Compare Figure 6 with the simplicity and elegance of the colour selection system on the Iwer rapier loom shown in Figure 7, which is similar in principle to the systems used on the Snoeck, Textima and other pirnless machines. The colour selection does not involve the movement of any large mass, so there are no limitations on loom speed and colours can be woven in any sequence. In addition the weaver can do something which is impossible on conventional looms—he can insert several colours of weft simultaneously and obtain a very subtle blending of colours. This point is of particular interest to weavers of furnishing materials, curtains and certain dress and suiting cloths; in this branch of the industry there is a trend to skip one important historical epoch in loom development—the conventional loom with automatic weft replenishment—and to change directly from the non-automatic conventional loom to the pirnless weaving machine.

Though the producer is mainly interested in a loom's productivity and the consumer in its versatility, the worker employed in the weaving industry is concerned with its effect on working conditions. Conventional weaving sheds are notorious for the almost unbearable noise caused mostly by the large shuttle banging to and fro. With rising standards of living and full employment, the weaving industry is finding it increasingly difficult to recruit young people prepared to work in such noisy places. Pirnless weaving machines reduce the noise in weaving sheds—particularly the water-jet and rapier looms. Such machines bring in their wake an air of progressiveness which will help to attract young people into weaving. It should also be remembered that shuttles occasionally fly out of conventional looms and cause a steady rate of accidents in mills. This danger is eliminated with pirnless looms, even of the gripper-shuttle variety.

I am often asked whether, in the long run, there is any future for weaving in view of the encroachments of knitting, non-woven materials and even paper and plastic sheeting. Answering this question means considering how closely our whole lives are associated with woven fabrics. We are wrapped in a woven napkin the moment we are born, and when we die we are laid in a woven shroud. Between these two events we use woven fabrics to protect ourselves against prying eyes, heat, cold and rain, to bandage our wounds, to sail our yachts to transport our coal, to line the tyres and seats of our cars, to cover our floors, to filter our chemicals, and in thousands of other ways. Woven fabrics offer a unique combination of dimensional stability with the ability to "drape", of tensile strength with flexibility, of heat insulation with porosity. They offer almost unlimited scope for patterning by the combination of different colours and yarns and by variations in the interlacing of the threads and they range in their structure from wide, open tyre cord fabrics with 4 weft threads per in. to dense velvetines with 400. Even if all these properties and end-uses could eventually be catered for by other types of materials, there is still plenty of work for many generations of weavers and looms. The new pirnless weaving machines will help them to do it more efficiently and in better conditions.

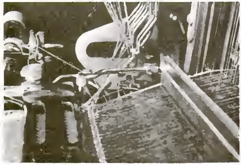


Figure 7. Colour selection mechanism of the Iwer Rapier loom. *This mechanism caters for eight weft colours. There is a small yarn guide for each colour and the colour selection is effected by lowering the appropriate guide so as to present the yarn to the rapier. In the photograph one of the guides is lowered and the weft thread has been gripped by the rapier.*

It seems to me

by Geminus

WHILE CERTAIN grave pundits have been shaking their heads over the difficulties of finding staff to implement the Robbins report, other university departments have discovered that finding the students may also be a problem. One young science department that I know had, two years ago, grown so that its intake of honours students amounted to close on fifty every year. But recently it has been hard to recruit potential students of suitable calibre. The result is that the intake of the honours school has fallen to fewer than forty in the last two years. There is no shortage of applicants, but only of those who qualify for entrance.

At first sight there is a conflict between this phenomenon and the basic argument of the Robbins Report that there is a growing demand for university education from properly qualified people. (In these days of early maturity, it has become patronising to use the word *schoolchildren*.) There is a danger that it will be used as yet another reason for insisting that Robbins is a hopelessly impractical prescription for higher education.

The real explanation of what is happening is at once more subtle and more important. I am prepared to believe that it is harder to find sufficiently bright potential undergraduates, though I do not share the implicit faith in the system of selection which some dons hold. The reason, however, is not that the nation's stock of talent is being exhausted, but that the teaching of science in the schools is sadly deficient. Disciplines that ought to be intellectually challenging are all too often taught as if they were humdrum preparations for well-paid vocations. Much science teaching in the schools is a way of blunting native wit.

In the final analysis, it would be wrong to put the blame for this on the schools alone. For do not the universities determine the temper of science teaching? An important reason why school teaching is often mediocre is that university teaching is often mediocre as well. Another is the way the schools have not been able to compete forcefully in the labour market.

What is to be done? In the first place it is essential that both schools and universities should recognise that the Robbins Report is a qualitative as well as a quantitative challenge. Much more must be done to isolate the hard intellectual content of science from the trivial dross in which it is often embedded. In the long run it is also necessary that society as a whole should recognise that it is not possible to skimp on one part of the educational pyramid (as the schools have been dealt with since the war), without throwing the rest of the system out of balance.

* * *

MOST OFTEN the small size of Britain is spoken of as a handicap, but it is also one of the great virtues of life on this off-shore island. There are now few places which are not accessible within a day. Many of the large cities are within three or four hours of each other, though it is not yet possible to get from one to another and back again with such ease that a full working day can be sandwiched in between. There is no reason, however, why that should not be recognised as a long-term objective of the British transport system. The aim should be to reduce the length of journeys between major British cities to no more than two hours by the year 2000.

At first sight the speeds of 200 m.p.h. which this programme would require can only be provided by air transport, and obviously there is plenty of room for a growth and an improvement of the air services between large cities. Even so, it is hard to see how airlines in their present form could meet all the need for rapid transport. Loading aircraft takes a considerable time. Getting from airports to city centres is a slow business. Then there is fog.

All this implies a need to pay serious attention to the potentialities of fast transport on the ground. Obviously a monorail system needs to be looked at carefully. The hovercraft which runs on rails may have great promise. It could even be that conventional railway locomotives have a great deal of "stretch" in them.

* * *

SIR RICHARD POWELL, the chairman of the departmental committee now looking into the future of atomic energy in Britain, must be surprised at the public attention accorded to his work. Most often the identity and even the existence of departmental committees of this kind passes without notice, for the British government traditionally cuts the figure of an omnipotent conjurer, able to produce decisions on complicated technical matters like rabbits out of a hat. On this occasion, of course, there is a great danger that when it comes to making a decision, several weeks from now, the government will be so deeply embroiled in electioneering that it will accept the committee's conclusions, lock, stock and barrel, or simply postpone things until after the election.

This will be a great pity, for some radical rethinking about the institutions concerned with atomic energy is now essential. The Atomic Energy Authority is, for practical purposes, an autonomous entity spending £50 millions a year on research and development, and dedicated to the view that it has a duty to provide the means for generating cheap nuclear power as quickly as possible. The Central Electricity Board, on the other hand, is becoming more and more belligerent in its advocacy of the view that a public corporation like itself must always follow the cheapest course. The result is that the CEGB is distinctly cooler than lukewarm towards the possibility that it might be asked to build one or two uncompetitive advanced gas-cooled reactors for the sake of the engineering development that this would make possible.

This situation is absurd. Only the narrowest reading of its terms of reference can permit the CEGB to shrug off responsibility for the long-term future of electricity generation. Only the gulf which separates the AEA and CEGB allows the AEA to develop kinds of reactors (such as the Advanced Gas-Cooled Reactor) which have not been approved of in advance by the only potential customer. (Some years ago the CEGB was extremely scornful of the AGR, but now appears to be more willing to accept that the design has promise.)

The simplest remedy would be to transfer the AEA to the umbrella of the Ministry of Power, where it would be easier to arrange that there should be regular confrontations of the AEA and CEGB. In that atmosphere it would also be easier to decide on the scale of research and development which the future of the fuel economy demands.

* * *

IN OHIO IT NOW seems to be taken for granted that Colonel John Glenn will win the right to be Democratic candidate for senator in the United States elections in November.

What interests me in all this is not so much the outcome of Colonel Glenn's contest, but the assumption that a man who has travelled around the world in a space capsule is more likely to win political power than one skilled in the ways of politics. This, certainly, is what some Ohio Democrats are banking on. It is alarming to think that they may be right, and to speculate about the consequences in Britain of the application of a similar principle.

Mr Richard Dimbleby would be Prime Minister, without a doubt. Sir Stanley Matthews would quickly establish himself as Chancellor of the Exchequer. Dr Barnes Wallis would be President of the Board of Trade, and Dr Francis Crick, Minister without Portfolio.

When Rutherford worked on radio

Before he embarked on the researches that founded nuclear physics, the young New Zealander began his scientific career with experiments on the newly discovered radio waves. With a minute bundle of steel wires he extended the range of radio detection from a few yards to half a mile or more

by Professor E. N. da C. Andrade, FRS

It is not always, perhaps not often, that the first researches of a great innovator in science are concerned with the subject or subjects on which his fame is founded. Of Bridgman, known for his epoch-making work on high pressure, it is true that his first paper and all his subsequent experimental work was concerned with the subject, but many of the founders of modern physics started their scientific life with work of which few have heard. Röntgen's first work was on the specific heat of gases and for many years he worked on high pressure before his great discovery of X-rays; Phillip Lenard and Niels Bohr both carried out their first researches on phenomena connected with the surface tension of water; Pierre Curie was well known for his investigations on magnetism, and Marie Curie accordingly did her first work on that subject, before they both became world famous for their researches on radioactivity.

Rutherford is another whose life work, on radioactivity and atomic structure, had nothing to do with his first adventures into the unknown in physics. These early endeavours, which showed him to be an outstanding experimenter, are little known today: although of considerable interest at the time, they did not leave an abiding mark in physics. They were concerned with the early days of wireless waves —radio—and it is not without interest to see how the young man, unaided, first made his way as an original investigator.

Ernest Rutherford in 1892. (The Collected Papers of Lord Rutherford, *Allen and Unwin)*

Rutherford was born in New Zealand in 1871, and in 1890 entered Canterbury College, in Christchurch, which was the nearest thing to a university in the region of his birth. In those days the total white population of the islands was only about a quarter of a million and naturally the facilities for study beyond school were not extensive. At Canterbury College there were five professors and fewer than two hundred students. The means for experiment were primitive—a galvanised iron shed served as the laboratory for both physics and chemistry. After taking his degree in 1893 Rutherford turned to research. He was encouraged by an enthusiastic eccentric, Bickerton, who was professor of both chemistry and physics, but knew comparatively little of either, and who spent much of his abundant energy in writing speculatively about abstruse astronomical questions.

Great excitement prevailed in the world of physics of those days about electromagnetic waves — "radio waves"—whose existence and elementary properties had been experimentally established by Heinrich Hertz a few years before Rutherford started his research. These waves were then produced by a spark discharge, a condenser and a self-induction in the circuit giving rise to a very rapid oscillation of electric and magnetic force. The resulting waves could be detected by a circular wire broken by a small gap, the induced alternations causing a minute spark. Hertz, who died at an early age in 1894, had succeeded in detecting the waves over a distance of some yards from their source.

Rutherford had read of these experiments, which naturally caused a scientific sensation, and decided to work in the radio field. In a book then famous, *The Alternating Current Transformer*, written by J. A. Fleming, who later invented the electronic valve, the young enthusiast had found a description of experiments by Hertz on the effect of rapid current alternations on the magnetic properties of iron and this seemed to him an attractive subject for research.

The facilities at his disposal would strike any young research student of today as impossibly primitive. The room in which he worked was a kind of cellar known as the "Den", used by students as a cloakroom. He had to make all his own apparatus. Furthermore, his only source of current was galvanic cells of a type known by the name of Grove. The Grove cell, invented in 1839, consists of an amalgamated zinc plate—the negative pole—in a porous pot containing sulphuric acid, which stands in a vessel of nitric acid containing a platinum sheet—the positive pole. These details are mentioned because every day Rutherford had to start by preparing a battery of Grove cells, which gave off disagreeable nitrous fumes, to supply his current. This preparation included the amalgamation—that is, coating with mercury—of the zinc plates. There were no accumulators to hand, and if there had been, there was no means of charging them. Research as Rutherford knew it in those days was a job involving much handiwork.

The apparatus used by Rutherford was of the simplest, made by himself without any proper workshop. His oscillating circuit consisted of a Leyden jar—a primitive form of condenser—in series with a self-induction, namely a solenoid wound on a glass tube, a spark gap being connected in parallel with the coatings of the condenser. The frequency of the electrical oscillations, round about 100 million cycles per second, was calculated in the usual way from the values of the capacity and self-induction. To charge up the condenser to sparking point he first made use of an electrical machine named after Voss, who devised it in 1880 on a then familiar pattern. It consisted of a glass or ebonite disc, turned by hand, with provision for the production and collection of frictional electricity. Such machines are laboratory curiosities nowadays. Later, Rutherford used an induction coil, which was the indispensable source of high potential in the laboratory until the end of the first World War, the current for this coil being supplied, of course, by his Grove cells.

With this apparatus he carried out experiments on the magnetisation of thin steel wires, whose diameter was from about a tenth to a hundredth of an inch, placed in bundles in the solenoid. Magnetisation was measured by a suspended magnetic needle furnished with a mirror, the deflection of which was given by the reflected beam from an oil lamp. Rutherford's first discovery was that the needles were, in fact, magnetised by the very rapid oscillations. This result was contrary to the general belief of the time that the two halves of each oscillation would cancel one another—an argument that does not allow for the decrease of the amplitude of the oscillation with time. It is of interest that Rutherford, in his account of the experiments, refers to the fact that Joseph Henry, the great American investigator after whom the unit of inductance is named, carried out some forty years earlier a few experiments on the magnetism produced by the discharge of a Leyden jar.

"The Den" at Canterbury College, where Rutherford carried out his work, was used by other students as a cloakroom. (The Collected Papers)

Rutherford established that the magnetisation produced by the extremely rapid oscillations was a surface or "skin" effect, there being magnetic layers, which changed in direction and thickness and diminished in strength, as the distance from the surface increased. He demonstrated this convincingly by dissolving away the surface with dilute nitric acid, making magnetic measurements at different stages.

Rutherford also discovered that strongly magnetised needles were demagnetised by the oscillations. He recognised in this effect the possibility of constructing a magnetic detector of electromagnetic oscillations, which he developed in a striking manner, as I shall describe later. Another discovery of significance was that the decrease of magnetisation was greater if the first swing of the oscillations was in the direction required to reverse the magnetisation, which was, perhaps, to be expected.

In his second New Zealand paper Rutherford reported his investigations of what he called "magnetic viscosity", in a research chiefly remarkable for a very simple but ingenious arrangement, involving a falling weight, by which time intervals down to a hundred-thousandth of a second could be measured. The general results were of no great significance. These first two papers were published in *Transactions of the New Zealand Institute* (1894) and have recently been republished in *Collected Papers of Lord Rutherford* (1962).

It was in 1895 that Rutherford came to work at Cambridge, having been awarded an 1851 Exhibition Science Scholarship. These scholarships, founded on the profits of the Great Exhibition of 1851, still exist and are much sought after: they are awarded to students who have shown promise in research and the recipient must continue his work in some institution other than that which recommended him. In those days one such scholarship was awarded to New Zealand every second year. It was only by fortunate chance that Rutherford received it, at any rate in the year in question, for it was first bestowed on another man, who decided for family reasons not to take it up. Rutherford was the second choice.

In England the great centre of research in physics was the Cavendish Laboratory in Cambridge, where J. J. Thomson was professor. He already had a great name, although his pioneering work on the electron, which brought him world renown, was only about to begin at the date when Rutherford

When Rutherford worked on radio *continued*

Rutherford's magnetic detector. (Cavendish Laboratory, Cambridge)

arrived. He had been appointed to the post at the early age of 28 and was still young, 38, at the time in question. Rutherford had made up his mind to work in his laboratory. Shortly before, J. J. Thomson had published, in a book dealing with recent researches in physics, a lengthy chapter on electromagnetic waves, which was probably a factor in Rutherford's decision. "J.J." welcomed him: regulations had just been passed by the Cambridge authorities which permitted students from other universities to work there, and it so happened that Rutherford was the first, though only by a short head, to be accepted.

He promptly started work in continuation of his New Zealand researches, devoting special attention to the method he had discovered of detecting electromagnetic waves by the demagnetisation of fine steel wires. As he said in his published account of the work, with the clarity and conciseness that characterised his writing from this date onwards: "The present paper deals with the subject of the magnetisation of iron by high frequency discharges, and the uses of magnetised steel needles for detecting and measuring currents of very great rapidity of alternation."

For detecting the arrival of the waves he finally used 20 pieces of fine steel wire, each about 0.007 cm in diameter and 1.0 cm long, insulated from one another by varnish and wound with a fine wire solenoid for conveying the current. The detector was thus about the size of a small pin. It was strongly magnetised and placed very close to a small magnometer, of the type already mentioned in connection with the New Zealand experiments. A Hertzian oscillator with large plates, each furnished with a knob so arranged as to constitute a spark gap, was used to produce the waves and many experiments were carried out to find the greatest distance at which they could be detected. This distance was given in the paper describing the work as over half a mile, but there is clear evidence that greater distances were established after this was written. Before Rutherford's work the distance was a matter of a few yards, so that he easily established a record for long-distance detection. Incidentally, he found that brick and stone walls allowed the waves to pass freely, as was perhaps to be expected. He also carried out many experiments on the detailed behaviour of iron in fields of very high frequency.

Writing about the matter some 13 years later, Rutherford said with justification: "This effect of electric oscillations of altering the magnetisation of wires is the basis of the magnetic 'detectors' developed by Marconi and others, which has proved one of the most sensitive and reliable of receivers in radiotelegraphy."

What Rutherford had created was, however, a detector, not a recorder such as Marconi developed. To record the Morse code, for instance, some method of restoring the magnetisation after it had been diminished was necessary, a problem later attacked by others. But Erskine-Murray has chronicled that in 1900 Rutherford suggested to him that electromagnetic oscillations might be made to record themselves on a steel band, a method later employed in the "telegraphone".

However, Rutherford, unlike Marconi, was not interested in the technological aspect of his work: he had no ambition to make a practical apparatus for radio communication. (It is recorded that he refused to act as expert witness in a legal case connected with radio transmission.) He published his Cavendish work, with a concise description of his earlier New Zealand work, in a paper entitled *A Magnetic Detector of Electrical Waves and Some of its Applications*, printed in 1897 by the Royal Society in its *Transactions*, a distinction of which he was proud. Just about the time of this publication he became intensely interested in electrical effects produced in air and other gases by the newly discovered X-rays and "J.J." invited him to collaborate in research in this field. This work became the focus of all his energy. It was the addition of "activity" to "radio" that led to the achievements which made Rutherford a founder of modern physics.

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Trends and Discoveries

British earthquakes may help geological studies

MORE SENSITIVE detecting apparatus, developed in response to the need to monitor underground nuclear tests, is now making it possible to consider studying the concealed geological structure of Britain—and eventually presumably that of other seismically "quiet" regions of the world—by means of naturally occurring Earth tremors. Previously such studies, which have considerable advantages over methods employing artificially produced seismic waves, have been confined to the earthquake belts of the globe. Three geophysicists at the UK Atomic Energy Authority's research centre at Blacknest, Reading, have just published a letter in *Nature* (Vol. 201, p. 484) describing two interesting events recorded by the Authority's experimental seismometer array at Eskdalemuir, not far from Dumfries.

The array consists of two lines of seismic detectors, each nearly nine km long, and each having 11 equally spaced instruments, with a common time base. The idea is to filter out tremors due to purely local disturbances and thus improve the signal-to-noise ratio; it is achieved in principle because crustal waves coming from some distance will arrive at successive intervals of time at each seismometer, whereas local disturbances will not, in general, arrive at the instruments in the same sequence. By introducing the appropriate time delay into each record of a tremor and adding all the records together, the readings caused by local events will tend to cancel one another out, but those from the distant earthquake, explosion, or other disturbance will add up to give a more pronounced record (see *New Scientist*, Vol. 15, p. 186 and Vol. 18, p. 311).

Last year, the Eskdalemuir array produced excellent records of a small earthquake felt in Glen Spean, Scotland, on 31 August, and of a rather larger one on the South Downs, noticed in Portsmouth on 25 October. The directions and distances of the two events were accurately given by the array, and analysis using different kinds of seismic waves gave a depth of 25 km, in good agreement with known depths of other European earthquakes.

A discrepancy between the velocities of the different types of waves as calculated from the array records, and those calculated by other means, indicates tilts in the underlying crustal layers, and the researchers, F. A. Key, P. D. Marshall and A. J. McDowall, say that the records "undoubtedly contain a great deal of information on the local crustal structure". They believe that seismic activity in the British Isles is sufficiently common to warrant further investigations. In fact, the Universities of Edinburgh and Durham are now taking steps towards this end.

Whistlers count electrons directly

WHISTLING atmospherics ("whistlers") have been observed for many years. The theory of their origin has developed from the pioneer work of L. R. O. Storey, of Cambridge. Whistlers, so called because they consist of a descending audio frequency tone, may be observed by means of specialised radio receivers and are known to be electromagnetic waves, produced by lightning discharges, that are guided through space by the Earth's magnetic field from one hemisphere to the other. During their passage the energy of the wave is dispersed, partly due to the effects of the ionosphere and partly due to their passage through the region of space in the vicinity of the Earth.

For some time it has been thought that whistler observations could increase our knowledge of the electrical conditions at several Earth radii. Several physicists have found various methods of determining the way in which the density of electrons in the these regions varies with distance from the Earth's surface, though some methods are only approximate and others require more data than can be obtained from whistlers alone.

C. A. Schoute-Vanneck and M. S. Muir, of the University of Natal, have now presented the results of their own work in this field (*Journal of Geophysical Research*, Vol. 68, p. 6079). They have shown that it is possible to calculate the variation of electron density with distance from the Earth by a direct method, which requires only a knowledge of the way in which the dispersion of whistlers varies with geomagnetic latitude.

The figures from the new calculations agree very reasonably with those of the earlier workers, and show that the average value of the near-space electron density falls smoothly from a value of 30 000 electrons per cu. cm, at a distance of 1.3 Earth radii from the centre of the Earth, to around 200 per cu. cm at four Earth radii. The results imply that this region is a good electrical conductor.

Lasers to line up electron spins

RESEARCHERS IN high energy physics sometimes need to produce polarised beams of energetic elementary particles for specific experiments in the study of particle interactions. Polarisation in this context means the aligning of the directions of "spin" of all the individual particles. As yet, however, there is no way of polarising beams of high-energy electrons. Three Russian workers at the Physical Institute of the State Committee for the use of Atomic Energy, at Ereven, have recently suggested that a laser beam might provide the answer (*Physics Letters*, Vol. 8, No. 1, p. 39).

V. M. Harutyunian and his colleagues have calculated that for electron beams with energies from a few GeV up to 40 GeV, and the most powerful ruby laser beam currenty available, the scattering of the light photons by the moving electrons should produce a recoil effect big enough to give the electrons a high degree of polarisation. The effect is greater for more energetic particles or a stronger laser beam. The process, they say, would also produce gamma rays with a high degree of polarisation.

Complete isolation for the mental patient

A COMPLETELY SOUNDPROOF room for the observation of psychological patients' reactions to drugs and other stimuli, and their behaviour in isolation from their normal surroundings, has been provided at the Barrow Neurological Institute, Phoenix, Arizona. All noise and vibration is excluded. Lighting, temperature and humidity can be precisely controlled. It has one-way vision windows so that the subject can be observed without his knowing, and provision is made for the electronic recording of his reactions.

In this chamber, investigations will be undertaken into the neurological correlation of the senses—sight, hearing and smell—and into the processes of thinking, learning and sleeping, as well as into emotional causes and effects in specific and general instances. Research may include the effects of environment on animal behaviour. This study of mental processes is expected to lead to improved treatment of neurological troubles.

The insulated room is really one room within another with a four-in. air space between the two sets of walls. Each wall is four in. thick, and consists of two steel plates with an acoustical filler between them. The floor is similarly made with a rubber mat top cover. In the side walls are two observation windows three ft square. Entrance is through a soundproofed double door.

Getting to know the heart better

THE ELECTROCARDIOGRAPH, as an instrument for recording the activity of the heart, has serious disadvantages, in that the limited number of electrodes arranged randomly on the chest give an incomplete recording of the electrical changes taking place. For the last two years P. Rijlant, Director of the Institute of Physiology, Brussels, has been experimenting on the application of an analogue computer to recording techniques in the attempt to give a *total* picture of the electrical activity of the human heart.

He has designed a special waistcoat containing 72 interconnected electrodes arranged round the chest. The careful positioning of and interconnections between these electrodes now make possible a complete and simultaneous recording of all the heart's electrical activities.

Besides obvious uses in cases of cardiac illness, this apparatus should prove a valuable research tool for determining the behaviour of the normal heart, and for detecting the small changes turbance. This may be particularly useful in the examination of certain occupational groups.

Lichens check development in higher plants

THAT LICHENS contain substances which stop the growth of bacteria and fungi is well known. G. Follmann and M. Nakagava, of Santiago de Chile, have shown that they also contain chemicals that affect the development of diverse higher plants. Powdered samples or water extracts of two southern Chilean lichens in the growth media of seeds of beans, oaks, wheat and a shrub related to hawthorn, retarded germination and slowed the growth of seedlings. Control beans, for example, germinated on the fourth day and their roots measured 25 mm after a further three days, while beans growing on the lichen extract media did not germinate till the seventh day, and their roots measured only 20 mm after a further five days. Some lichens may thus have ecological effects on the composition of forests (*Naturwissenschaften*, No. 22/63, p. 696).

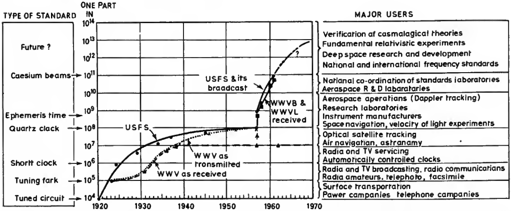
A ring round Jupiter?

ASTRONOMERS have always thought that the famous ring-system of Saturn is unique in the solar system; a faint ring round Neptune, reported during the past century by Lassell, Challis and Bond, seems to be definitely nonexistent. Now, however, the Russian astronomer S. Vsekhsvyatsky, of the Ukraine, has made the unexpected suggestion that Jupiter too may be associated with a very thin ring, composed of material of low density.

Vsekhsvyatsky has made a close study of drawings of Jupiter done by experienced observers in many countries, and believes that a very thin, broken streak in the region of the planet's equator indicates the existence of a ring. He considers that it has been formed as a result of gigantic outbursts in Jupiter itself, and that its composition is identical with that of the ring-system of Saturn.

These conclusions are likely to be hotly challenged. There is no theoretical bar to a Jovian ring, but if it exists it is extremely elusive, and confirmation is likely to prove a very difficult matter.

Frequency standards over four decades



OVER THE PAST 40 years frequency standards, which are important for many purposes, have been enormously improved due to the development of better and better kinds of "clocks". The graph above shows how the United States Frequency Standard (USFS), maintained by the National Bureau of Standards since 1920, has increased in precision by some seven orders of magnitude in this time. The present caesium beam clock at the NBS Boulder Laboratories is accurate to two parts in a million million; for measurements limited to about ten hours, the accuracy is nearly ten times better than this. Current NBS research is aimed at producing a caesium clock with twice the present precision, and at developing a thallium beam device and a hydrogen maser, both of which may be better by a factor of ten. The sharp bend in the solid curve represents the transition to an atomic frequency standard.

The NBS makes its frequency standards available to users by high-frequency broadcasting stations at Beltsville, Maryland (designated WWV), Maui, Hawaii (WWVL), and the recently inaugurated low-frequency stations WWVB and WWVL at Ft Collins, Colorado. The dotted line before 1957 represents the stability in frequency of the transmitted signals (after this date, it is essentially the same as the USFS). The dashed line shows the stability of the received signals; it levels off at one part in 10^7 because of ionospheric limitations due to the way in which HF signals are repeatedly reflected between the Earth and the ionosphere during transmission. Latterly, the stability of the broadcast signals has improved considerably owing to the use of LF transmission which is ducted between the Earth and the ionosphere with very little deterioration.

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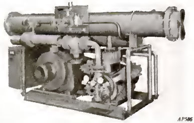

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LETTERS

Darwin and natural selection

Sir,—In his interesting article *How Darwin came by his theory of natural selection* (23 January) Sir Gavin de Beer explains how "the guardians of the Establishment in England" fought hard against the idea of evolution in the 1790s. But he does not mention the most famous of their attacks, the satire *The Loves of the Triangles* (1798), written by Canning (who was Foreign Under-Secretary in Pitt's Government) with two collaborators. This attack was directed partly against Godwin but chiefly against the best-known exponent of evolution in the 1790s, Erasmus Darwin, who propounded his evolutionary theory in his medical textbook *Zoonomia* (1794) and had also written the poem *The Loves of the Plants* which served as the model for Canning's parody. Sir Gavin de Beer points out that Charles Darwin never succeeded in appreciating the political implications of evolution, and this becomes all the more surprising when one remembers that his grandfather had suffered such politically-inspired attacks for expressing similar opinions.

DESMOND KING-HELE.

3 Tor Road,
Farnham,
Surrey.

All an accident

Sir,—Sir Gavin de Beer ably describes how Darwin came by his theory of natural selection, but he seems to make the same mistake as did Darwin who, he says, "conceived natural selection from the start as a positive creative process".

Surely, this is untrue. Either a variation of a morphological pattern makes survival more certain, or less so, or it is superfluous, and these results are as accidental as are the environmental conditions, at any given time. Any direct or oblique conception of creation cannot be entertained.

Sir Gavin's contention that the expression "natural selection" is not ideal arises from that fact, for selection can be only artificial. Darwin used the adjective "natural" because he was impressed by the possibility of an evolutionary sequence as distinct from the methods used by man—who deliberately exploits the environment.

He showed a lamentable lack of care in the use of terms, which sometimes suggest an opposite meaning—as did Herbert Spencer.

Had he used the term "survival of the fitter", one would understand clearly that variations respond successfully to environment according to their comparative adequacy.

It is the organism which produces the causes of its destiny—and by accident. Hence, another word "adaptation" cannot be employed. Lamarck made that error. The accident of minute, genetical mutations is an unconscious expression of structural change.

Darwin today would agree that his theory of evolution might be expressed as an efflorescence of morphological patterns arising from chemical combinations, the survival of which is made possible by the absence, at any given time, of lethal conditions.

An absence, let it be noted, as accidental as are mutations.

Organic evolution is a remarkable natural history of accidents, and all the more wonderful because in it is disclosed no sign of selective creation.

E. C. PEAKE.

The Royal Alfred Home,
Belvedere,
Kent.

Strangelove-hate

Sir,—Your remarks about the film *Dr Strangelove* (see "Notes and Comments", 30 January) seem extraordinary to me. At a fast reading, they appear to imply that conventional warfare is always presented in films as heroic and noble. This is not true. However, it is undeniable, unfortunately perhaps, that warfare produces heroic action and noble emotions and therefore those can fairly form part of war film.

But most of all, I am surprised at your reaction to the portrayal of Dr Strangelove himself. Apparently it is permissible to fill the script with what you call, significantly, the now classic figure of the mad general, yet we must not have a scientist held up to the same distorting mirror. Why not? The general in the film is just as grotesque when compared to the ordinary run of generals as is Strangelove beside the ordinary scientist.

The weapons that the general uses would not exist without the cooperation of scientists; there are expatriate scientists, and others, working on weapons in the United States and Russia, and I have no doubt that, in the circumstances so frighteningly shown in the film some scientists would be concerned with the intellectual problem of setting the life cycle in motion again. Indeed, wouldn't this be a good thing?

I think you are suffering from the usual—and understandable—reaction of those who, enjoying attacks on people or things they do not like, suddenly find that the attack has switched to someone or something they respect. In an ecstacy (your spelling) of shock, they shout, "Unfair!"

The suggested idea that Dr Strangelove was introduced to focus the hatred of the audience on scientists in general is staggering. Will it really make people hate the man from the Road Research Laboratory or the Cancer Research Institute who is also a scientist. Come, come—it might make people think twice about scientists who work on nuclear weapons and this is fair enough as an aim for a film.

ROY HERBERT.

16 St Paul's Place,
London, N1.

Air samples and the plastic bag

Sir,—It was interesting to have confirmation from a rather unexpected source of the unreliability of plastic bags for the collection of air samples for analysis (see *The breath of a drunken driver*, 9 January). In the course of some investigations of the atmosphere in wells and boreholes effects similar to those reported by the Medical Research Council team were observed in these laboratories.

Thus in one experiment in which a polythene bag was used to collect breath samples, carbon dioxide content fell in 24 hours from 3.4 per cent to 0.2 per cent (minus 3.2 per cent) while the oxygen content rose from 17.5 per cent to 18.5 per cent (plus 1 per cent).

Using a rubber football bladder the effect was slower but still marked. In four days carbon dioxide fell from 3.6 per cent to 0.6 per cent (minus 3 per cent) and oxygen rose from 17.6 per cent to 18.8 per cent (plus 1.2 per cent).

It will be seen that in neither of the examples quoted did the gain in oxygen balance the loss of carbon dioxide. Could it be that the apparent increase in the alcohol content of breath samples stored in plastic bags mentioned by Dr Peter Stubbs was merely an increase in concentration due to the relatively greater loss of carbon dioxide?

It would be interesting to have the views of Dr B. M. Wright on this or anyone else who may have encountered the same phenomenon.

R. D. MACLEAN.

Metropolitan Water Board
Laboratories,
Metropolitan Water Board,
Water Examination Department,
177 Rosebery Avenue,
London, EC1.

The lunar atmosphere

Sir,—Mr J. H. Fremlin's letter (30 January), containing some criticisms of an earlier communication of mine ("Letters", 16 January) on the possible effects of the ionisation of a tenuous atmosphere round an astronomical body of lunar mass, is interesting, but not quite convincing. His argument may be summed up thus: There can be no lunar

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atmosphere, because if there has never been a lunar atmosphere, it could not have developed. To this extent it assumes from the start what it purports to prove. Furthermore, even on his premises, a sustained volcanic selenological "episode" could defeat the mechanism he invokes.

The point, however, is that we have no right to assume that the Moon has never had an appreciable atmosphere, and the data regarding the rate of escape of gas fromt he interior (past and present), as well as the amount of gas that may be held by sorption in the porous surface are lacking. Any argument that requires bolstering up by reference to an hypothetical situation in a remote and unverifiable past, such as the time of origin of the solar system, is a little thin.

Mr Fremlin states *ex cathedra* that "a positive layer at the top of the atmosphere might indeed induce a negative charge below it, but this could be enough only to reduce the field of the positive charge to zero: it could not induce so *large* a negative charge as to produce a net negative field to induce a second positive layer and so on." So says he, but this is no proof. In fact, the effect should be comparable to that of the hydrogen bridge in chemical bonding. The positive charge will be farther away from the gas layer immediately below the negative charge than is this negative charge, and so there will most certainly be an excess negative charge to induce a local positive charge, and so *on*. The only question is how important this effect will be.

Here much will depend on where the supposed "top of the atmosphere" lies and the density of the atmosphere in question.

I envisage the following situation, which is not usually considered.

The body in question, which may be the Moon in this particular case, has no high atmosphere comparable to ours, but only a thin gas halo, consisting primarily of the interplanetary gas concentrated in its gravitational field. This gas is electrically neutral, at any rate on the night side. There is, however, a substantial amount of gas held by absorption in the porous or particulate surface, as well as possibly some vaporisable precipitates.

As the surface heats up at sunrise some of this captive gas is released and becomes ionised. The charge is positive and the induced charge in the ground negative, thus binding the gas to the surface. Moreover, it must be borne in mind that at least some of the surface will be still in darkness at this time. The continued evolution and warming-up of the gas will cause it to spread upwards, but probably not very high and here the "concertina effect" may intervene. What the net result of the various processes will be depends on several variables, all of which are conjectural. But the basic difference between Mr Fremlin's and my own assumption is that he thinks the ground will be charged positively and so repel the positive ions, and I have suggested (see *Life beyond the Earth*, Hutchinson, 1963) that the charge may be negative and so retain them.

Both effects seem theoretically possible and could even occur simultaneously in different parts of the surface at different times. What actually happens we do not know and it is better to wait until we find out than being too cock-sure now.

The Moon is not the only satellite we know, and at least Titan has an appreciable, spectroscopically ascertainable, atmosphere. The escape velocity from Titan is 1.7 mi/sec as against 1.5 mi/sec from the Moon; the surface gravities are 0.17g and 0.16g respectively, not such a lot of difference! What differs is the intensity of solar radiation. This does show that the final outcome is a matter of numerical interaction of conflicting factors.

V. A. FIRSOFF.

c/o Bank of Scotland,
Crieff,
Perthshire.

The British stake in CERN

Sir,—Geminus states (9 January) that the British government "is now committed to CERN to the tune of some £10 million a year".

In view of the current discussion on the question of financing research in high-energy physics, a discussion in which Geminus now joins, it is important to get the facts right. The recently approved budget for CERN in 1964 calls for total contributions from member states of just under £9 million, of which the British government pays almost one quarter, that is about £2¼ million.

It would be out of place for me to comment upon the substance of the article, but to put the future into perspective, it may be of interest to note that the European Committee on Future Accelerators estimated that if both the storage rings for the CERN PS and a new 300-GeV accelerator were to be built, the total expense of these and the existing CERN set-up would rise to about £60 million per year in 13 or 14 years' time. Assuming the British government's share were to remain at 25 per cent of this, their commitment then would be about £15 million per year; not very much more than present levels of expenditure, for incomparably better research facilities.

G. H. HAMPTON,
Directorate Member for
Administration

European Organisation for Nuclear
Research,
Geneva.

Books

Natural selection and natural theology

by Sir Gavin de Beer, FRS

Darwiniana: Essays and reviews pertaining to Darwinism. By Asa Gray, edited by A. Hunter Dupree.
Harvard University Press/Oxford University Press, 327 pp., 40s.

THERE IS an interesting parallel to be drawn between Asa Gray and John Ray his predecessor by two centuries. They were both clerks in holy orders, botanists, passionately interested in the problem of species, and possessed of a gentleness and charm of manner that make their works delightful to read, as well as persuasive.

Gray was one of the few men to whom Darwin confided his views on species, and Gray was in a position to defend these against Agassiz even before the *Origin of Species* was published. From the start, he accepted Darwin's demonstration of the mechanism of evolution by natural selection, but he read into it an interpretation that enabled him to believe that evolution, and the method by which it was brought about in nature, did not destroy a belief in design and the operation of an intelligent creator. This was possible for Gray because he held that the variations on which natural selection worked had themselves been beneficently designed. Darwin brought his ponderous thinking machine to bear on this suggestion, and when it was proposed that certain articles by Gray should be reprinted in Britain, Darwin, it appears, even suggested that they might bear the title, *Natural selection not inconsistent with natural theology.*

The scrutiny to which Darwin subjected this argument is plain to see in the correspondence exchanged between the two men during 1860. Darwin's approach to the problem was purely empirical. He could not believe that the many variations in pigeons' tails were designed, for if so, they had been designed to please pigeon-fanciers, nor that a beneficent and omnipotent god would have designedly created the Ichneumonidae with the express intention of their feeding within the living bodies of caterpillars. He therefore rejected design in variation, but protested that his views were not at all necessarily atheistic, because he could not account for the authorship of the laws of nature according to which, in his view, everything happened. As it has turned out, Darwin's rejection of design in nature is supported not only by the palaeontological record of continuous extinction (a running record of failure if there was design), and by the genetic demonstration that the "breeze" of mutations is not favourable, for nearly all mutations are acted upon adversely by natural selection in the environment in which they mutated, and this is, as Sir Ronald Fisher showed, why they have become recessive.

Gray went on to give Darwin credit for having brought teleology and final causes back into biology. This paradoxical view was due to Darwin's demonstration of the importance of adaptation to ecological niches: organs serve a purpose, and in Gray's theological sense, purpose meant purposive design.

In this connexion, Gray quoted a passage by a remarkable and forgotten man, William Kingdon Clifford, which in the end has told directly against him. Clifford pointed out the difference between two meanings of the word purpose. In the first, the image or idea of the end preceded the use of the means. This is theological teleology and Aristotelian final causes. The second meaning is that an adaptation is useful even if it originated without any design at all but by accident, as under natural selection. With astonishing cogency Clifford argued that "since the process of natural selection has been understood, purpose has ceased to suggest design to instructed people, except in cases where the agency of man is independently probable". It was in order to express this important concept of undesigned purposefulness that Colin Pittendrigh introduced the useful term teleonomic. Hume would have applauded.

In the 1860s, however, Gray and Darwin drifted further apart in their views, as the latter became more and more convinced by the evidence that variation was not designed, let alone by an intelligent agent. He wrote to Gray, "I see a bird which I want for food, take my gun and kill it, I do this *designedly*. An innocent and good man stands under a tree and is killed by a flash of lightning. Do you believe . . . that God designedly killed this man?" And so Darwin was led to the Concluding Remarks in his *Variation of Animals and Plants under domestication*, published in 1868, in which he summed up his arguments against design.

Professor Hunter Dupree has performed a real service to biologists by bringing forward these problems, for although as he says Gray's *Darwiniana* was already an anachronism when it appeared in 1876, the problems have been made all the more actual by the increasing weight of evidence against design. Now that biologists have become obliged to believe that the universe is not constructed in such a manner as to admit of revelations from personal gods to chosen peoples, or of long range specific prophesies, or of interference with the laws of nature, they may begin to ponder more and more over Darwin's dilemma: "My theology is a simple muddle". Is it vain to hope that discussion on this point may be conducted with that same sweetness of temper as was shown by Gray and Darwin, despite the fundamental difference between their views?

Over in a flash

Physics of Lightning. By D. J. Malan. English Universities Press, 176 pp., 25s.

A LIGHTNING flash is the abrupt and vivid culmination of a gradual and largely invisible process; a sudden intense spark from a cloud containing electrically charged regions. It might perhaps be natural if the bulk of research on lightning were directed towards understanding the processes by which thunderclouds form and by which electric charges of different polarity are produced. It would be all too easy to dismiss the lightning discharge itself as a simple example of the electrical breakdown of air, and the end product of a complex thermodynamic and electrical process. In fact, studies of lightning reveal a fascinating structure of events within what often appears to the eye as a single flash.

Much of what is known of the fine structure of lightning, the leader process, return strokes and dart leaders to further return strokes, is known from the historic series of investigations carried out by Professor Schonland and his colleagues at the Bernard Price Institute in South Africa. As a member of the team responsible for this research Dr Malan accordingly writes with authority.

Although the title might lead one to expect lightning alone to be discussed, the author does, in fact, discuss the whole range of associated subjects, from the formation of thunderclouds, through the discharge itself, to the effects of lightning on electricity supply systems, buildings and electrical communication. Since Dr Malan writes for

Books *continued*

the general reader as well as the specialist there is nothing in his book which cannot be understood with a background of sixth-form science, and little which will not be instructive to the interested layman.

Unfortunately this duality of purpose spoils the work as a serious addition to the literature on the subject. The scope is too wide to be encompassed in a book of this size, and specialist readers will find that each topic has been too briefly treated. Such readers will also find the bibliography quite inadequate and might also feel that lightning research in this country has not been given due mention.

J. H. GRIDLEY.

Caledonian stocktaking

The British Caledonides. Edited by M. R. W. Johnson and F. H. Stewart. Oliver and Boyd, 280 pp., 63s.

THERE are three kinds of scientific symposium. The least satisfactory is that in which a committee agrees on a title and then hopes that enough speakers come forward with faintly relevant papers. In the second kind, appropriate speakers are specifically invited, but the choice of their topics is left to their own idiosyncrasies. In the best kind of symposium, carefully selected specialists are invited to speak on carefully selected (and carefully integrated) topics. This book records a symposium of this last and best kind, which was held at Edinburgh in December 1961.

The Caledonians were that ancient range of mountains that stretched from Western Ireland, through Wales, northwest England and Scotland to Scandinavia at the end of Lower Palaeozoic times, and whose remains are seen in the older rocks of those regions.

The history of the British part of that range is here approached from several different directions. Thus D. A. Bassett deals with the stratigraphy (in the broadest sense) of the Welsh sediments, E. K. Walton with those of the Southern Uplands and J. L. Knill with those of the Dalradian Series in the Highlands. Each deals with the peculiar problems of his own field in a different way, but put together for the first time, they present a coherent picture of the whole.

Similarly, N. Rast deals with the structure and metamorphism of the Dalradian rocks, whilst J. G. Ramsay does the same for the Moinian and Lewisian. These subjects are all very complex, but for once we can distinguish the regional wood from the minor structural trees.

A useful chapter by L. E. Long and R. St. J. Lambert sums up the absolute age determinations that have been made on the Moinian rocks, and there are two more specialised and specific chapters—by R. St. J. Lambert on mineral reactions at Lewisian-Moinian contacts and by E. L. P. Mercy on the geochemistry of some of the Caledonian rocks—which, excellent though they are, do not seem to fit into the present setting.

Added to these is a brilliant opening chaper by Professor T. N. George on the Palaeozoic growth of the British Caledonians, in which he finds something original to say even about such well-trodden ground as south Shropshire. The whole is brought to a neat conclusion with a summing up by Professor J. Sutton who includes several important matters, such as the Torridonian, which are not dealt with adequately elsewhere, and he also relates the British story of the Caledonides to that of other regions.

In reading this modern survey of an ancient field, one notes that the contributors are almost all of the post-war generation of geologists, and certainly all are still actively engaged in their specialities. They are also all forward-looking scientists, who have moved out of the dustier corridors of academic research. At the same time one notes (with mixed feelings) certain interesting absences — the classical Lower Palaeozoic stratigrapher — the distinguished contingent of Caledonian geologists working in Ireland—the igneous petrologist—the Geological Survey — and one regrets, as always, the inexplicable delays of scientific publication. Nevertheless, we have here what the editors call a "Caledonian stocktaking" which will be an invaluable source of information and ideas for a long time to come.

D. V. AGER

Out of the smoke

Control of Air Pollution. By Alan Gilpin.
Butterworth, 495 pp., 120s.

HERE IS an exhaustive text book designed to meet the needs of local government officers, various industrial users and of student public health inspectors.

It starts with an excellent general study of the nature and effects of air pollution and of the simple methods of measuring it and, being very well written, it would appeal to anyone interested in finding a readable, up-to-date account of air pollution. References to the medical aspects are necessarily very brief. However, there is a widespread bibliography given after each chapter enabling further studies to be undertaken.

The second part of the book deals with furnaces, fuels and firing methods and gives a very thorough account of the scientific principles involved, as well as the technical engineering problems in industry. This is certainly an account for the serious student and should interest those facing such difficulties in industry. The descriptions are straight-forward and wide use is made of simple diagrams.

The third part deals with the practical application of the Clean Air Act, 1956. The chapters on grit and dust and on chimney heights are excellent. (Meteorological factors, however, are discussed briefly in the chapter on chimney heights, and in such an exhaustive book, more space could usefully have been given to these). This section naturally runs into the difficulty that orders, directions or even legislation may change during publication. And this has indeed happened, as new directions from the Ministry of Local Government and Housing have recently been issued, which affect the type of appliance which will rank for grant.

This section is illustrated by describing the various stages in introducing a smoke control order in Wallasey in 1959. Although this helps to introduce wide detail to the student, there is the difficulty that local procedures may be confused with national ones. Thus, the details of assessment scales in Wallasey for providing financial assistance for persons who may suffer hardship seem unnecessarily complicated. Many local authorities have met this problem in simpler ways which are not mentioned.

The remainder of the book discusses other problems of air pollution including the special difficulties of the iron and steel, ceramics, cement, lime and glass industries and power stations. These are well and sensibly dealt with.

The problem of atomic energy and air pollution is briefly touched upon. One factor which could have been stressed more in this respect is that pollution from such a source can never be dealt with by local action alone. For this reason, the United Kingdom Atomic Energy Authority have been given wide powers but much coordination and co-operation is needed locally.

A final chapter on odour control of only four pages (in a book of 495 pages) is disappointing. So many problems have occurred recently in industrial areas including oil refineries, abattoirs, that more description would have been valuable.

Generally this is an excellent major text book on the subject with a bias mainly towards industrial furnaces, fuels and firing methods. It certainly deserves to be widely read by public health inspectors in industrial areas. It should also find its way into all libraries for students. I am much less certain that it will become a book actually to be owned by all student public health inspectors—it is very costly for such purpose. Perhaps Mr Gilpin will be encouraged to add to Part 1 to make a shorter students' textbook. From the readable way he presents his material, I am certain that, if he did so, it would be widely welcomed.

J. R. MEREDITH DAVIES

CONTRIBUTORS

David Fishlock (*The widening spectrum of lasers*) is Technology Editor of *New Scientist*. .(*pages 326-327*)

Michael James Lighthill (*Market needs and technical possibilities*) has been Director of the Royal Aircraft Establishment, Farnborough, since 1959, having previously held the Beyer Professorship of Applied Mathematics at the University of Manchester. He was elected a Fellow of the Royal Society in 1953. Dr Lighthill is the author of many scientific communications and one book, *Introduction to Fourier Analysis and Generalised Functions*. (*pages 328-330*)

Pierre Satre (*Travelling by air in 1984*) is Technical Manager of Sud-Aviation, where he is primarily concerned with civil aviation problems. He is celebrated for his work on the Caravelle airliner. Educated at the Ecole Polytechnique and the Ecole Nationale Supérieure de l'Aeronautique, he is married with five children. He has been awarded the Légion d'Honneur. (*pages 331-332*)

Ronald Macalister Macdonnell (*Towards complete safety in the air*) became Secretary-General of the International Civil Aviation Organisation, Montreal, Canada, in 1959. He was formerly Deputy Secretary of State for External Affairs in the government of Canada. Mr Macdonnell, born in 1909, is a graduate of the University of Manitoba, and holds a degree in history from the University of Oxford. (*pages 332-333*)

John Eustace O'Brien Martyn (*Unintentional duplication of research*) works in research in documentation for Aslib. He is particularly interested in the relationships between scientists and their information sources. Aged 34, Mr Martyn is married and includes among his spare-time occupations reading, photography, comparative religion and giving up smoking. (*page 338*)

Vivian Frederick Maynard FitzSimons (*Life in an ancient desert*) is Director of the Transvaal Museum, Pretoria, where he previously worked in the Division of Lower Vertebrates and Invertebrates. His chief interest is in the reptiles. Dr FitzSimons, aged 62, once enjoyed athletics, rugby, tennis and golf; he now plays bowls. His other interests include nature conservation, philately and reading. He is a member of numerous scientific bodies, and has written two books on South African reptiles. (*pages 340-343*)

Peter Blumfeld Collins (*Genetic weapons in insect control*) is a science writer, who has been Science Correspondent of the *Sunday Times* and more recently Agricultural Editor for UNCSAT. His chief interests include problems of food and agriculture in the less-developed countries, insect-borne tropical diseases and problems of mass infestation by insects. Mr Collins, who is 54 and married, was educated as an entomologist. He is interested in deserts, and has travelled widely—in the Sahara, Nigeria, Iraq and the Indian sub-continent. He is the author of several books. (*page 351*)

Kurt Greenwood (*New looms that streamline weaving*) is Head of the Weaving Department at Shirley Institute, Didsbury, Manchester. His main interest is in the physics of cloth formation. Mr Greenwood, aged 45, was born and educated in Vienna, but came to England in 1938, where he took an external degree in physics at the University of London. He has worked in a cotton mill for seven years, and believes that he is probably the only Fellow of the Institute of Physics who holds a weaver's union card. He has contributed a section to the book *Modern Developments in Weaving Machinery*. (*pages 352-356*)

Edward Neville Da Costa Andrade (*When Rutherford worked on radio*) is Emeritus Professor of London University, where he held the Quain Chair of Physics from 1928 until his retirement in 1950. He was holder of an 1851 scholarship and, after graduating and carrying out his first research in London, he worked at Heidelberg, Cambridge and Manchester. He was elected a Fellow to the Royal Society in 1935. During the second World War he acted as scientific adviser to the Ministry of Supply. More recently he was Director of the Royal Institution. He is particularly known for his work on flow in solids and liquids. His publications range from *An Approach to Modern Physics* to *Poems and Songs*. (*pages 358-360*)

Gavin de Beer (*Natural selection and natural theology*) was formerly director of the British Museum (Natural History) and before that was Professor of Embryology at University College, London. He was President of the fifteenth International Congress of Zoology in 1958, and is a Past-President of the Linnean Society and of the Zoology section of the British Association. Sir Gavin was knighted in 1954 and is a Fellow of the Royal Society. He is now a director of Thomas Nelson & Sons, and continues to enjoy research in literary history and the application of science to the solution of problems in pre-history, history and archaeology. (*page 367*)

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Please quote reference CST 64/3.

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Applications are invited for a Lecturer in Animal Ecology in the Department of Forestry and Natural Resources. The successful applicant will be expected to lecture in the general field of Animal Ecology, and to develop courses of instruction on the management of exploited natural animal populations. He will also be expected to pursue and promote research on relevant problems. The salary scale is £1,250 x £60 — £1,490: Bar. £1,550 x £60 — £1,670 x £80 — £2,150 per annum, with placement according to qualifications and experience, and with superannuation benefit and family allowance where applicable. Applicants are also invited to write to the Head of the Department, Professor J. N. Black, at 10 George Square, Edinburgh 8, for information on the proposed development and interests of this Department.

Applications (six copies), giving the names of two referees should be lodged with the undersigned not later than 21st March, 1964.

CHARLES H. STEWART
Secretary to the University.

Old College,
South Bridge,
Edinburgh 8

January, 1964

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Applications are invited for the post of LECTURER IN CHEMISTRY in the Faculty of Science. Candidates should have special interest in the physical chemistry of high polymers. Duties to commence as soon as possible. Salary scale £1,250 to £2,150 per annum; initial salary according to qualifications and experience. Membership of F.S.S.U. and Children's Allowance Scheme. Applications should be sent not later than February 29th, 1964, to the Registrar, the University, Manchester 13, from whom further particulars and forms of application may be obtained.

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b. Lecturer in Horticulture with special reference to the new course in Recreational and Decorative Horticulture.
c. Assistant Lecturer in Agriculture.
d. Assistant Lecturer in Horticulture.
e. Assistant Lecturer in either Agriculture or Horticulture with special reference to Machinery.
f. Two Assistant Lecturers in Agriculture including Horticultural Science, one of whom should have a special interest in Applied Chemistry and the other in Applied Biology.

The salary scales are as follows:
Lecturer: £1,670 to £1,895.
Assistant Lecturer: £630 to £1,560 or £730 to £1,760.

One of the appointments to be made in Applied Science will carry a special allowance of £140 per annum. Free board residence in return for supervisory duties in respect of students in residence will be available for at least ONE of the Assistant Lecturers.

Further details in respect of these appointments and application forms may be obtained from The Principal to whom completed application forms must be returned no later than three weeks after the appearance of this notice.

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A vacancy will occur on the staff of the Department of Glass Technology for a LECTURER to be appointed as from 1 October 1964. Preference would be given to a Chemist or Glass Technologist with some industrial experience. It is hoped that the person appointed will be interested in the application of physical chemistry to problems in inorganic glasses and that he will be able to assist in the undergraduate teaching on the chemical side of the Department's work. However, applications from other graduates will be considered. The research work of the Department covers a wide range including such topics as the electrical properties, the spectroscopy and fluorescence of glasses, oxidation-reduction processes, diffusion, the physical chemistry of glass formation, nucleation and crystal growth. Initial salary scale £1,250 x 60-1,670 x 80-2,150, with F.S.S.U. scale £1,250 x 60-1, 670 x 80-2, 150, with F.S.S.U. provision and family allowance. A grant towards removal expenses will be made. Further particulars may be obtained from the Registrar to whom applications (4 copies) should be sent by 7th March, 1964.

UNIVERSITY OF ST. ANDREWS

The University Court invites applications for the Baxter Chair of Applied Mathematics in Queen's College, Dundee. Salary £2,350 plus family allowances; F.S.S.U.; grant towards expenses of furniture removal. Applications (25 copies) (one copy in the case of overseas applicants) including the names of three referees must be lodged by 24th March, 1964 with the Secretary of the University, College Gate, St. Andrews, Fife, from whom further particulars may be obtained.

UNIVERSITY OF EDINBURGH

Department of Forestry and Natural Resources

Lecturer in Aerial Photo-Interpretation

Applications are invited for a Lecturer in Aerial Photo-interpretation in the Department of Forestry and Natural Resources. The successful applicant will be expected to lecture on the application of aerial photography to problems in land use in its widest connotation, and to give elementary instruction in ground survey methods. He will also be expected to engage in research and to develop facilities for this purpose. The salary scale is £1,250 x £60 — £1,490; Bar: £1,550 x £60 — £1,670 x £80 — £2,150 per annum, with placement according to qualifications and experience, and with superannuation benefit and family allowance where applicable. Applicants are also invited to write to the Head of the Department, Professor J. N. Black, at 10 George Square, Edinburgh 8, for information on the proposed development and interests of this department.

Applications (six copies), giving the names of two referees should be lodged with the undersigned not later than 21st March, 1964.

CHARLES H. STEWART,
Secretary to the University

Old College, South Bridge,
EDINBURGH 8.

VICTORIA UNIVERSITY OF WELLINGTON New Zealand

Senior Lecturer in Computing Mathematics

Applications are invited from suitably qualified persons for the above-mentioned post. The successful candidate will be charged with the development of computer use and instruction within the University.

Salary will be £1,750 per annum rising to £2,000, the initial salary being determined according to the qualifications and experience of the appointee.

Approved fares to Wellington will be allowed for the appointee, his wife and his dependent children; in addition, actual removal expenses will be allowed within specified limits.

Further particulars and information as to the method of appplication are obtainable from the Secretary, Association of Commonwealth Universities (Branch Office), Marlborough House, Pall Mall, London, S.W.1.

Applications close in New Zealand and London on 31st March, 1964.

UNIVERSITY OF EDINBURGH

Department of Mathematical Physics

Applications are invited for one or more additional Lectureships in Mathematical Physics. The Principal research interest of the Department is in the theory of elementary particles, but applicants working in any branch of Mathematical Physics or Applied Mathematics will be considered.

Salary Scale £1250 x £60-£1490 = Bar = £1550 x £60 - £1670 x £80 - £2150, with placement according to qualifications and experience, and with superannuation benefit and family allowance where applicable.

The successful candidate or candidates will be expected to take up the appointment on 1st October, 1964. Further particulars may be obtained from the undersigned, with whom applications (six copies) giving the names of two referees, should be lodged not later than 28th February, 1964.

CHARLES H. STEWART
Secretary to the University.

January, 1964.

East African Agriculture and Forestry Research Organisation

Taxonomic Botanist required to supervise and carry out all the routine tasks of a large herbarium including the naming of collections of East African plants sent in by government officials and private persons, answer a large range of botanical queries and carry out research on the taxonomy of the local flora, with limited facilities for making collections in the field.

Candidates should have a good knowledge of taxonomic botany and a knowledge of the routine of a herbarium. A University degree in botany is desirable, but might be waived in the case of a person of known standing in taxonomy who has a number of taxonomic papers to his credit.

Appointment on contract of one or two tours of 24 months. Inclusive salary in scale £1,221-£2,097 a year. Gratuity of 25% of total emoluments. Education allowance. Free passages. Furnished accommodation available at reasonable rent. Generous leave. Free medical attention.

Applicants should be nationals of the United Kingdom or the Republic of Ireland and send their full name and brief particulars of their qualifications and experience to Director of Recruitment, Department of Technical Co-operation, Stag Place, London, S.W.1, quoting RC.264/348/010.

DONCASTER TRAINING COLLEGE
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Application is invited from men and women for the following posts at this expanding college.—

Lecturer in Biology. Strong interest in field work desirable. Two new laboratories being built. Senior Lecturer/Lecturer in Mathematics to share in work of department, i.e. Supplementary Course, Main and general courses. Interest in modern mathematics and primary school work desirable.

Salary in accordance with the Pelham Scales:—Senior Lecturer £1,748 to £2,045 p.a. Lecturer £1,230 to £1,740 p.a.

Further particulars and application forms may be obtained from the undersigned on receipt of a stamped addressed envelope and completed forms must be sent to the Principal, Doncaster Training College, High Melton, Doncaster as soon as possible and no later than 14th February, 1964.

M. J. PASS
Chief Education Officer.

Education Offices,
Doncaster.

THE OFFICE OF THE LORD PRESIDENT AND MINISTER FOR SCIENCE requires a Principal Information Officer having special experience in the preparation of written material on Technological and Scientific subjects.

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Initially this will be a temporary appointment, but there are good prospects of establishment for the successful applicant. The salary range will be £2,237 to £2,572 p.a.

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UNIVERSITY OF BIRMINGHAM
Department of Geography

Applications are invited for the post of Assistant Lecturer (£1,000 x £50 to £1,150) or Lecturer (£1,250 x £60 — £1,678 x £88 to £1,838; £1,030 x £80 to £2,150) in GEOGRAPHY with special reference to Meteorology and Climatology.

Applicants must have had an adequate training in Mathematics and Physics. Facility in the use of statistical methods would be an added recommendation. Initial salary according to qualifications and experience. Duties to begin 1st October, 1964.

Applications (5 copies), naming three referees, must be sent by 29th February, 1964, to the Assistant Registrar (Arts and Law), The University, Birmingham 15, from whom further particulars can be obtained.

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Education Committee

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St. Mary's Road, Ealing, W.5
Tel. EALing 0162, 8163

Principal, Dr O. G. Pickard, B.Sc. (Econ), M.Com., F.I.O.M.

SCHOOL OF BUSINESS

Applications are invited for the following appointment in the School of Business to be effective from as early a date as possible:—

RESEARCH ASSISTANT in MARKETING — Applicants should be graduates. A science degree with some industrial experience would be advantageous. The successful applicant will be expected to initiate and execute a research project on technical and/or industrial marketing as part of the general research programme of the School's Division of Marketing. There will be considerable freedom in choice of subject. There will also be opportunities for teaching experience. The appointment will be for approximately two years in the first instance.

Salary Scale: Within the range £830-£1,550, plus London Allowance.

Forms of Application and further particulars from the Principal (S.A.E. please) to whom completed applications should be returned within a fortnight of the appearance of this advertisement.

C. E. GURR,
Chief Education Officer

WYE COLLEGE
(University of London)
Lecturer in Applied Entomology

Applications are invited for the post of Lecturer in Applied Entomology in the Department of Biological Sciences. The appointment will be made according to qualifications and experience in the Lecturer Grade for which the salary scale is £1,250 x £60 to £1,670 x £80 to £1,830; (Bar.) x £80 to £2,150 with special London Allowance, £68, children's allowances and superannuation under the F.S.S.U.

Further particulars may be obtained from the Secretary, Wye College, near Ashford, Kent, to whom applications should be submitted by 30th March, 1964.

UNIVERSITY OF ST. ANDREWS

The University Court invites applications for the Gregory Chair of Applied Mathematics in St. Salvator's College, St. Andrews. Salary £3,350 plus family allowances; F.S.S.U.; grant towards expenses of furniture removal. Applications (25 copies) (one copy in the case of overseas applicants) including the names of three referees must be lodged by 24 March, 1964 with the Secretary of the University, College Gate, St. Andrews, Fife, from whom further particulars may be obtained.

JOHN INNES INSTITUTE seeks to appoint a Head of its Department of Cell Biology. The successful candidate will be expected to head a group working on cell physiology, cell multiplication and molecular genetics. The appointment will be to the Principal or Senior Principal Scientific Officer grade in the scale £1,894-£3,475 p.a. according to qualifications and experience, with membership of the F.S.S.U. Applications, with full details and the names of three referees, should be addressed to the Secretary, Bayfordbury, Hertford, Herts, by the 29th February, 1964.

THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY
(Faculty of Technology in the University of Manchester)

Applications are invited for a new appointment as LECTURER IN THE DEPARTMENT OF MATHEMATICS, with corresponding title and status in the University of Manchester.

Professor J. S. Griffith, in the Department, is interested in various branches of theoretical chemistry, especially ligand-field theory, group-theoretic tensor methods and the use of the digital computer in semi-empirical theory. It is hoped that a successful candidate might have research interests in these or in related fields, or that he might wish to have his research directed into one of them in the future.

Commencing salary according to qualifications and experience in the scale:

Lecturer: £1,250 x £60 — £1,678 x £80 — £2,150 per annum.

Conditions of appointment and forms of application may be obtained from the Registrar of the College Sackville Street, Manchester 1, to whom completed applications should be forwarded by Saturday, 29th February, 1964.

UNIVERSITY COLLEGE OF SWANSEA
Chair in Industrial Engineering

Applications are invited for a newly-established CHAIR in INDUSTRIAL ENGINEERING in the Department of Engineering. Applicants should have an interest in the quantitative methods and economic aspects of engineering design and industrial organisation, but might have special interests in operational research methods or optimum (economic) design of engineering systems, or statistics and computational methods, etc.

Further particulars can be obtained from the Registrar, University College of Swansea, Singleton Park, Swansea, to whom applications should be sent by Monday, February 18, 1964.

UNIVERSITY OF MELBOURNE
Chair of Chemical Engineering

Applications are invited for the Chair of Chemical Engineering which has just been created, though a Department has been in existence within the Faculty of Engineering for ten years.

The salary of the Professor will be £A4,750 per annum. Superannuation similar to that under the F.S.S.U. of the United Kingdom will be provided.

Conditions of Appointment are available from the Secretary, Association of Commonwealth Universities (Branch Office), Marlborough House, Pall Mall, London, S.W.1.

Applications close in Australia and London on 31st March, 1964.

It is hoped that the Professor will be able to take up this appointment in 1964.

ROYAL HOLLOWAY COLLEGE
(University of London)

Applications are invited for the post of LECTURER OR ASSISTANT LECTURER in BOTANY, with interests in plant physiology, tenable from 1st October, 1964.

The appointment is open to a man or a woman. Initial salary according to qualifications and experience within the scales approved by the Senate of the University of London. Particulars may be obtained from the Principal, Royal Holloway College, Englefield Green, Surrey, to whom applications should be sent as soon as possible.

APPOINTMENTS AND SITUATIONS VACANT

THE UNIVERSITY OF LIVERPOOL

Applications are invited for the post of Research Assistant in the Department of Histology. The salary will be within the range £900-£1,108 per annum. Interest in or experience of tissue culture, histochemistry, photography or electron microscopy would be advantageous. Applications stating age, qualifications and experience, together with the names of three referees, should be received not later than 24th February, 1964, by the Registrar, from whom further particulars may be obtained, quoting reference number CV/14/NS.

COMMONWEALTH OF AUSTRALIA
DEPARTMENT OF SUPPLY

WEAPONS RESEARCH ESTABLISHMENT SOUTH AUSTRALIA

VACANCIES— SCIENTIFIC STAFF

The Weapons Research Establishment, Salisbury, which is situated approximately 15 miles from Adelaide, the capital city of South Australia, is seeking the services of appropriately qualified and experienced persons to fill a number of Scientific Officer vacancies. Details of the positions are given hereunder.

The present annual salaries (Aust.), are as follows:—

Senior Scientific Officer ...	£2,751-£2,111
Higher Scientific Officer ...	£2,331-£2,631
Scientific Officer, Grade 1	£1,571-£2,231

Conditions

(1) Commencing salary will be determined according to qualifications and experience.

(2) Official Charter Aircraft, or first class sea passage, at the discretion of the Department may be provided for the successful applicant and dependants (wife and dependent children).

(3) Assistance will be given in obtaining married accommodation.

(4) General conditions of employment as applicable under the Commonwealth of Australia Public Service Act will apply.

SPACE PHYSICS

Senior Scientific Officer

Duties: Position No. 267. Research and development in quantum electronics with emphasis on the generation, detection and amplification of coherent sub-millimetre waves.

Higher Scientific Officer

Duties: Position No. 74. Research and development in the circuitry of micro-electronic devices at ordinary or low temperatures and their application in communication and automatic computing.

Duties: Position No. 81. Research and development in sub-millimetre wave generators, detectors and amplifiers with emphasis on their applications in spectroscopy, optics, communications and instrumentation.

Qualifications: (Above positions: 74, 81, 267). Appropriate First or Second Class Honours degree with experience or special qualifications in one or more of the following fields:—quantum mechanics, physical optics, crystal physics, electron physics or infra-red spectroscopy.

Duties: Position No. 72. A member of a team undertaking theoretical studies on guided weapons systems involving compiling, checking and using complex mathematical models of such systems. Digital and analogue computers are used for this work.

Qualifications: First or Second Class Honours Degree in Science, Applied Mathematics or Engineering with research experience in servo-mechanisms, automatic control, information theory or weapon systems.

TRIALS

Senior Scientific Officer

Duties: Position No. 35: In charge of a section responsible for research into telemetry systems.

Higher Scientific Officer

Duties: Position No. 218. Research and development in telemetry systems applicable to the performance testing of guided missiles. The work includes investigations into techniques, and the development of appropriate receiving equipment, high frequency and video magnetic tape recording equipment and demultiplexing equipment.

Qualifications: (Above positions 30, 215). Appropriate First or Second Class Honours Degree plus relevant research experience.

Duties: Position No. 78. Responsible to a Senior Scientific Officer for undertaking operations research into problems associated with organisation and planning of trials of guided weapons and test vehicles.

Qualifications: Appropriate Honours Degree with some relevant experience in Operations Research.

WEAPONS RESEARCH AND DEVELOPMENT

Senior Scientific Officer

Duties: Position No. 132. Responsible for research in modern electronic techniques used in the development of the test instrumentation associated with guided weapons including a study of the factors affecting the reliability of airborne electronic components of guided weapon systems.

Qualifications: Appropriate First or Second Class Honours Degree and extensive relevant research or development experience. Experience in execution of Services guided weapon equipment trials is desirable.

Duties: Position No. 20. Responsible for research associated with the application of new electronic techniques to weapon systems including the assessment of the operational and environmental factors affecting the design of Military electronic equipment.

Qualifications: Appropriate First or Second class Honours Degree in Physics or Electrical Engineering with several years experience in the design of precision electronic equipment involving solid state devices.

Scientific Officer, Grade I

Duties: Position No. 133. Research associated with the development of electronic equipment used in the simulation of elements of guided weapon systems.

Qualifications: Appropriate First or Second Class Honours Degree.

Applications—Forms obtainable from the Senior Representative, AV/198/5, Department of Supply, Australia House, The Strand, London, W.C.2, with whom completed applications should be lodged by 26th February, 1964.

MOUNT VERNON HOSPITAL
Northwood, Middx.

TECHNICIAN required to work in laboratory engaged in the study of the Chromosomes of Tumours. Previous experience in techniques used in the study of Chromosomes would be advantageous but is not essential. Salary dependent upon qualifications and experience. Applications with two names for reference to Hospital Secretary.

RUGBY SCHOOL. Applications are invited for the post of a SENIOR LABORATORY STEWARD. Candidates should have had some experience in physics laboratory techniques and, preferably, some knowledge of organisation and administration. The salary scale for this responsible position is £850 to £1,060 per annum. Help will be given with accommodation. Full particulars may be obtained from the Senior Science Master, Rugby School Science Laboratories, Barby Road, Rugby, to whom applications should be sent as soon as possible.

APPLICATIONS are invited for an appointment as a Junior Technical Officer in a group investigating cytogenetic effects of radiation. Minimum qualification (below the age of 22): G.C.E. at 'A' level in two science subjects including one in a Biological subject. Salary scale £500 p.a. at the age of 18, rising to £1,020 p.a., with good prospects of promotion. Applications, giving full particulars and the names of two referees, should be addressed to: Administrator, Radiobiological Research Unit, Medical Research Council, HARWELL, DIDCOT. Berkshire. Ref: HJE/1.

KING'S COLLEGE HOSPITAL
Denmark Hill, London, S.E.5

BIOCHEMIST required to assist with research into the biological action of peptides. A grant of £788 p.a. will be payable.

Applications and enquiries to the House Governor by 22nd February, 1964.

CHERRY VALLEY FARMS LIMITED
seek the services of a
GRADUATE
(25-35)

The person appointed will manage the largest duck hatchery in the United Kingdom. He will be entirely responsible for production and records which include extensive pedigree work.

The person appointed will be meticulous in the maintenance of data and have sufficient knowledge and analytical ability to be able to draw the right conclusions. He will be exceptional in ability to control staff and maintain extremely high standards of hygiene.

He will have the capacity to earn promotion within three years, and will therefore train his own replacement.

Applications to: Cherry Valley Farms Ltd., Rothwell, Lincoln.

Research Association requires experienced

Metallurgist

for a senior Liaison Department post. Enthusiasm for technological progress, the ability to put new ideas across clearly and a flair for writing are essential characteristics for the work which involves translating research results into industrial practice and the identification of industry's research requirements.

Preferred age 30 to 40.

Write: Secretary, B.N.F.M.R.A., Euston Street, London, N.W.1

UNIVERSITY OF OXFORD
Department of Engineering Science

Research Fellowship

Applications are invited for the post of Research Fellow in the Department of Engineering Science. The post is tenable for three years and the successful candidate will probably have a doctorate or several years experience in research. He will be required to work on the problem of the noise generated by separated flows for which purpose the Department has been awarded a special research grant from the D.S.I.R.

Salary £1,100 p.a. with F.S.S.U. benefits.

Further particulars may be obtained from Administrator, Department of Engineering Science, Parks Road, Oxford, to whom applications (3 copies) and the names and addresses of 3 referees should be sent by 20th February, 1964.

Scientific Civil Service

SCS

SCIENTISTS IN GOVERNMENT SERVICE

The following are examples of existing vacancies which may be filled at SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER level.

NATIONAL PHYSICAL LABORATORY
Teddington, Middx.
Physicist or Applied Mathematician for RESEARCH IN ACOUSTICAL PROBLEMS involving wave propagation, networks, reverberation theory and the statistics of random processes. An interest in experimental as well as theoretical work an advantage.

SIGNALS RESEARCH AND DEVELOPMENT ESTABLISHMENT
Christchurch, Hants
Physicists or Electrical Engineers for COMMUNICATIONS SYSTEMS: Applications of the latest techniques in communications, and especially in digital systems.

ORDNANCE BOARD
Charles House, Kensington High Street, London, W.14
Mathematician/Statistician for planning and assessments of trials of various weapons and equipment for the three Services and the development of new statistical techniques and methods of numerical analyses.

ADMIRALTY RESEARCH LABORATORY
Teddington, Middx.
Physicists with INTERESTS IN OCEANOGRAPHY for military oceanographic research.

There are many other vacancies in most scientific disciplines.

Recruitment by the Civil Service Commissioners is to permanent and pensionable posts.

APPLICATION FORMS from Civil Service Commission, 23 Savile Row, London, W.1. stating age and qualifications and quoting S/52-53.

EXPERIMENTAL OFFICER CLASS SPRING — 1964 — RECRUITMENT

Careers in SCIENCE and TECHNOLOGY are offered to men and women with qualifications in MATHEMATICS, PHYSICS, CHEMISTRY, BIOLOGY, METEOROLOGY, ENGINEERING and GEOLOGY as Assistant Experimental Officers and Experimental Officers, in Government Scientific Establishments.
QUALIFICATIONS: University Degree, Dip. Tech., HNC, etc., and candidates under age 23 may offer lower qualifications (minimum: G.C.E. "A" level in 2 Scientific or mathematical subjects).
SALARY AND AGE LIMITS:
Experimental Officer (age 26-30) £1,164-£1,431.
Assistant Experimental Officer (ages 18-27) £490 (at 18) - £858 (at 26 or over) - £1,053.
Salaries supplemented in London area. Aid given for further education. Promotion prospects. Pensionable posts.
APPLICATION FORMS AND BOOKLET from Civil Service Commission, 23 Savile Row, London, W.1, quoting S/577-578/64. Closing date 13th March, 1964. (Further recruitment in Autumn, 1964.)

SCIENTIFIC ASSISTANTS

Interesting posts in research and development are available in Government Scientific Establishments where the fields include Physics, Electronics, Meteorology, Chemistry, Engineering, etc. Candidates are invited to apply direct to Establishments or Departments of their choice, or (aged 17, with at least 1 year's experience in scientific work) to the Civil Service Commission for permanent posts.
SALARY: £356 (age 18) - £678 (age 25) - £835. Promotion prospects. Assistance with studies. 5 day week generally. Salaries supplemented in London Area.
QUALIFICATIONS: (minimum) G.C.E. with 4 "O" level passes including a scientific/mathematical subject and English language. Or O.N.C. (or equivalent).
WRITE TO: Civil Service Commission, 23 Savile Row, W.1, for list of Departmental addresses, or further information and application form for permanent appointments, quoting S/50.

MINISTRY OF POWER SAFETY IN MINES RESEARCH ESTABLISHMENT

(i) SENIOR OR JUNIOR RESEARCH FELLOWSHIP
Post at Sheffield for Mathematician, Physicist or Engineer to study fluid flows, in the general area of density currents, relating to nuclear reactor safety.

QUALIFICATIONS: 1st or 2nd class honours degree in appropriate subject plus 2 years' postgraduate research (3 years' for Senior Fellowship) during which a high standard of research ability must have been demonstrated. Previous experience in fluid mechanics an advantage.

SALARY: Senior Research Fellowship between £1,428 - £1,755 annually. Junior Research Fellowship between £975 - £1,318 annually.

APPLICATION FORMS from Civil Service Commission, 23 Savile Row, London, W.1, quoting S/578/SM. Early application advised.

(ii) SCIENTIFIC OFFICERS/SENIOR SCIENTIFIC OFFICERS
The establishment is engaged in research into methods of advancing the safety and promoting the health of persons employed in and about mines, with two research stations, one at Sheffield where new and well equipped laboratories have been built adjacent to the university, the other near Buxton, where large scale experiments are conducted.

There are vacancies in the fields of Mathematics, Fluid Mechanics, Metallurgy, Frictional Ignitions, Electrical Hazards Research and Strata Control.

Good prospects for permanent, pensionable appointments.

Applications to Director, S.M.R.E. Redhill, off Broad Lane, Sheffield 3.

D.S.I.R.

(i) HEADQUARTERS
State House, High Holborn, London, W.C.1.
PRINCIPAL SCIENTIFIC OFFICER required for an unestablished vacancy in the DEVELOPMENT SECTION of the INDUSTRY DIVISION. The Section's purpose is to help British industry in the APPLICATION OF ADVANCED RESEARCH AND DEVELOPMENT. Duties will include the technical assessment, placing and progressing of development projects, including direct liaison with industry.

QUALIFICATIONS: 1st or 2nd Class honours degree, or equivalent, in engineering or applied physics, with at least three years' postgraduate experience in research and development. Experience both within industry and otherwise would be an advantage. Candidates should have the ability to write concisely, an aptitude for administration, and an interest in the practical application of results.

SALARY: £1,959 - £2,711. (Ref: E/AH/078).

BUILDING RESEARCH STATION
Garston, Watford, Herts.

(ii) ASSISTANT EXPERIMENTAL OFFICER/EXPERIMENTAL OFFICER as technical translator/abstractor of technical literature dealing with wide range of subjects in building science and technology.

QUALIFICATIONS: Science degree, Dip. Tech., H.N.C., or equivalent; intelligent interest in information work, sound knowledge of at least 2 foreign languages required; one Scandinavian language an advantage. Opportunity for further language study. (Reference: E/AF/068.)

(iii) ASSISTANT EXPERIMENTAL OFFICER to join research team concerned with air-movement processes in buildings.

QUALIFICATIONS: Degree, H.N.C. (or equivalent qualification) in Physics or Maths. Interest in fluid dynamics required. (Reference: E/AF/096).

APPLICATION FORMS from Directors at above addresses quoting appropriate reference. Closing date 24th February, 1964, for (i) and 28th February for (ii) and (iii).

MINISTRY OF AGRICULTURE, FISHERIES AND FOOD

(1) FOOD SCIENCE LABORATORY, London
ASSISTANT EXPERIMENTAL OFFICER/EXPERIMENTAL OFFICER for post concerned with basic studies on the physical and chemical changes occurring during food storage and on methods of minimising deterioration. Degree (or equivalent) in chemical or biochemical subject preferred. Interest in physical chemistry desirable but not essential.

APPLICATION FORM from Ministry of Agriculture, Fisheries and Food, Estab. 1B, Room 612, Great Westminster House, Horseferry Road, London, S.W.1.

(2) PLANT PATHOLOGY LABORATORY, HARPENDEN

ASSISTANT EXPERIMENTAL OFFICER/EXPERIMENTAL OFFICER for work in a small group in the chemistry department on the determination of residues of pesticides in foodstuffs or vegetable origin.

Degree, H.N.C. (or equivalent) preferred. Some experience with thin layer, paper or gas/liquid chromatography techniques desirable but not essential.

APPLICATION FORM from Director, Plant Pathology Laboratory, Hatching Green, Harpenden, Herts.

Closing date for both posts 18th February, 1964.

WAR DEPARTMENT CHEMICAL DEFENCE EXPERIMENTAL ESTABLISHMENT

Porton Down, Near Salisbury, Wilts.

ASSISTANT EXPERIMENTAL OFFICER/EXPERIMENTAL OFFICER required in Physiology Section.

APPLICATION FORM from The War Office (C5F), London, S.W.1.

SCIENTIFIC OFFICER/SENIOR SCIENTIFIC OFFICER

SALARIES: S.O. £791-£1,300
(Increments and special £95 award for approved post-graduate experience.)
S.S.O. £1,438-£1,772.
(Starting salary may be above minimum.)
Salaries are supplemented in the London area.

QUALIFICATIONS:
S.O.: 1st or 2nd Class Hons. Degree or Dip. Tech. in appropriate subject. Age under 29.
S.S.O.: As above plus at least 2 years' postgraduate research. Age 26 to 31.

ASST. EXPERIMENTAL OFFICER/EXPERIMENTAL OFFICER

SALARIES: A.E.O. £490 (age 18)-£691 (age 22)-£858 (age 26)-£1,053.
E.O. £1,164-£1,431.
Salaries are supplemented in the London area.

QUALIFICATIONS:
Degree, Dip.Tech., H.N.C. or equivalent in appropriate subject. Under age 22, minimum qualification is 2 G.C.E. 'A' levels in Scientific subjects. A.E.O.: age 18-27. E.O. 26-30.

Full details of careers in the SCIENTIFIC CIVIL SERVICE are available on request from Civil Service Commission, 23 Savile Row, W.1

Harwell

The ATOMIC ENERGY RESEARCH ESTABLISHMENT

invites applications for a post in the

HARWELL LIBRARY

The duties of the post are to take charge of one of the three main Sections of the Library (the Cataloguing Room, the Reading Room, or the Report Room).

A Professional library qualification and experience of organisation and staff management in a scientific or technical library are essential.

Depending upon qualifications and experience, the salary will be within the range £1,250 - £1,535 per annum.

Superannuation scheme; housing purchase assistance.

Please send a POSTCARD for application form to:

Personnel Department (A5043/215)
ATOMIC ENERGY RESEARCH ESTABLISHMENT
Harwell, Didcot, Berks.

THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY

Radiation Protection Service

Applications are invited for the appointment of a SENIOR TECHNICIAN to work in laboratories at the University, the College of Science and Technology and the Manchester Royal Infirmary where X-ray machines and radioactive materials are used. The duties include radiation monitoring and contamination surveys, supervision of radioactive waste disposal, calibration of nucleonic equipment and assistance with the health physics work of the Radiation Protection Service.

Applicants should hold a H.N.C. or equivalent in Physics or Electrical Engineering and must have a driving licence. Some laboratory experience would be an advantage but training in radiological health will be given.

Salary will be on the scale £810-£960 per annum at a commencing point according to qualifications. Supplementation of £30 or £50 per annum is payable for approved qualifications. Five-day 40-hour week. Superannuation scheme. Canteen facilities.

Applications must be submitted on an Application Form for which a self-addressed envelope should be sent to the Bursar at the Manchester College of Science and Technology, Sackville Street, Manchester 1, quoting reference number RS2. Completed applications must reach the Bursar by 11th February, 1964.

BEDFORDSHIRE EDUCATION COMMITTEE

Northfields County Secondary School, Dunstable

Required as soon as possible—qualified laboratory technician. Duties include preparation of solutions and demonstration experiments and maintenance of apparatus and laboratories. 38 hours per week. Salary £280 per annum at 16 years, £485 per annum at 22, £520 per annum at 23 rising to an eventual maximum of £725 per annum. At age 18 superannuation under Local Government Superannuation Scheme. Apply by letter to the Headmaster stating any qualifications or experience and giving names of two referees who can speak with knowledge of the candidate. Candidates with no previous experience of this kind of work will be considered if they are adaptable.

SURREY EDUCATION COMMITTEE — Senior Technician required for Chemistry Laboratories. Should hold City & Guilds Science Laboratory Technicians Advanced Certificate or equivalent qualification. Duties: to design, construct and repair teaching and research apparatus. Competence in electronic circuity essential and some experience in glassblowing a recommendation. Salary. Misc.: V., £730-£890 p.a. plus London Allowance £25/£48 p.a. Details and applications form from Principal, Kingston College of Technology, Penrhyn Road, Kingston-upon-Thames.

THE GAS COUNCIL

The Research Division at Watson House, Fulham, has a vacancy for a

GRADUATE

with a first or second class honours degree in physics,

to work on problems associated with the combustion of town gas. The field of work includes studies of the combustion properties of gases from new sources and the design principles of burners for these and conventional gases in relation to domestic and commercial application.

Commencing salary will depend upon qualifications and experience. There are excellent prospects for promotion.

Applications, giving full details, should be sent in the first instance to:—

The Staff Controller
North Thames Gas Board
30 Kensington Church Street, London, W.8
quoting reference NS/1788

WESTERN REGIONAL HOSPITAL BOARD, SCOTLAND

Applications are invited for the appointment of

Deputy Regional Physicist

The person appointed will be second in command of an active department, with a staff of more than 60 people, devoted to the formulation of scientific advice and the provision of scientific help in the hospital service. Candidates should have good academic qualifications (preferably including a higher degree), wide interests in classical and contemporary physics and responsible experience in one or more of the following fields:—

- (a) research in a university department or government laboratory (including the supervision of scientific and technical staff);
- (b) teaching in a university;
- (c) application of physics to problems arising in clinical research;
- (d) measurement and control of ionising radiations;
- (e) design and development of scientific instruments.

The salary scale will be £1,825-£2,520 and initial placing on that scale will depend on relevant qualifications and experience. There will be in addition a responsibility allowance of £350 per annum. The initial salary inclusive of the allowance will not exceed £2,618 per annum. After a reasonable period of satisfactory service the person appointed will be able to submit an application to be graded as Top Grade, which carries with it the salary scale of not less than £2,825-£2,985 per annum.

The post is superannuable and applications with the names of two referees should be sent before 29th February, 1964, to the Secretary, Western Regional Hospital Board, 251 Sauchiehall Street, Glasgow, C.2

MINISTRY OF AGRICULTURE, FISHERIES & FOOD require (a) unestablished AGRICULTURAL ECONOMISTS (Main Grade or Assistants) and (b) unestablished ASSISTANT STATISTICIANS. Prospects of permanency through C.S.C. Open Competitions

QUALS. Candidates for (a) must have University degree, normally with 1st or 2nd Class Hons. in economics, agriculture, horticulture or closely related subject, or comparable quals. At least 3 years' appropriate post-graduate or other experience essential for main grade. Candidates for (b) should preferably be of 1st or 2nd Class Hons. degree standard and have a good knowledge of mathematical or economic statistics.

Minimum age: at least 20 (26 for main grade agricultural economists). DUTIES of (a) include investigation of changes in the economic and financial conditions of the agricultural industry and factors affecting agricultural and horticultural production; analysis of farm incomes and costs; and preparation of material for farm management advisory work.

DUTIES of (b) can cover a wide field of agricultural and food statistics including analysis and interpretation of censuses and sample surveys, forecasts of production trends and crop, feedingstuffs and commodity prices, and calculation of quantity and value of agricultural output.

SALARY SCALES (inner London): Agricultural Economists (Main Grade) £1,498-£1,837. Assistant Agricultural Economists and Assistant Statisticians £836-£1,369. Starting salary may be above minimum.

APPLICATION forms from The Manager (PE. 1276 A/B), Ministry of Labour, Professional & Executive Register, Atlantic House, Farringdon Street, London, E.C.4. Closing date 19th February, 1964.

CADET STATISTICIANS

Home Civil Service

Pensionable posts for men and women at least 20 and under 27 on 1.8.64 (extension for service in H.M. Forces or Overseas Civil Service and/or approved post-graduate experience) with degree or Dip.Tech. (preferably with 1st or 2nd class honours) in mathematics, economics, or other appropriate subject; final year students may apply. Cadets will be required to take 1-year university course for higher degree or post-graduate certificate or diploma in statistics during 1964/65; those who qualify will become Assistant Statisticians (Inner London salary scale £846-£1,369), with promotion prospects to £3,965 and above. Salary during course £755 in Inner London (£745 if under 21); £735 in Outer London (£728 if under 21); £700 elsewhere. University fees paid; book grant. Write Civil Service Commission, 22 Savile Row, London, W.1. for further information and application form, quoting 5829/64. Closing date 28th February 1964.
(1)

SCIENTISTS AND ENGINEERS FOR RESEARCH

We are now beginning a further phase in the expansion of our wide-ranging research activities and invite applications for the following important positions in our well equipped laboratories.

TEAM LEADERS — At least six years first class post-graduate research experience for these posts which have outstanding prospects.

PHYSICAL CHEMIST

To lead a team studying electro-chemical phenomena. Research experience of electro-chemistry or of properties of interfaces with sound understanding of the basic principles of chemical equilibria and kinetics is necessary. An interest in both true scientific investigation and practical applications of the results is very desirable.

PHYSICIST

To lead a team studying mechanical properties of polymeric materials and chemical methods of affecting these properties. An aptitude for instrumentation in addition to an understanding of the nature of organic materials and their deformation is desirable.

RESEARCH STAFF — A University degree, Dip.Tech., HNC, HND, or professional qualifications, but research experience not essential.

MECHANICAL AND ELECTRICAL ENGINEERS, CHEMISTS AND PHYSICISTS

To investigate a very wide range of topics, including study of materials (glass, semi-conductors, metals, etc.), mechanical and chemical processes, instrumentation and electronics. Practical men with versatile minds, as well as those with an academic approach are required.

ASSISTANTS — Young men and women with "O" levels, "A" levels, ONC, and wishing to study or continue studies for HNC or B.Sc.

To take extremely interesting positions in the research laboratories with excellent prospects in all the above mentioned fields. Successful candidates will be given every encouragement to gain their qualifications by part-time studies.

The working conditions are excellent and attractive salaries will be paid.

Please write to:— **Administration Manager, Research Unit**

WILKINSON SWORD LTD.

Poyle Mill Works, Colnbrook, Bucks.

THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY

(Faculty of Technology in the University of Manchester)

Applications are invited for a RESEARCH AWARD, tenable in the first instance for two years in the Department of MECHANICAL ENGINEERING, to carry out an investigation into the fundamental aspects of the grinding of metals. The successful candidate, who should have a good Honours degree (or equivalent qualification) in Physics, Mechanical Engineering or Engineering Science, may be able to work for a post-graduate degree. The award is valued at £750 per annum from which the usual University fees will be payable.

Applications, which must include particulars of the candidate's qualifications and experience, should be addressed to the Registrar of the College, Manchester 1, by the 29th February, 1964.

FULMER RESEARCH INSTITUTE

Stoke Poges, Buckinghamshire

Vacancies exist for Physical or Inorganic Chemists for Research in Inorganic Thermochemistry and High Temperature Reactions. Much of the work is of a fundamental nature and intended for eventual publication. A competitive salary between £850 and £1,500 p.a. according to qualifications and previous experience will be paid.

Applicants who should have a University degree are invited to write to the Director of Research

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SECRETARY required from 24th February for Head of Department of Biochemistry of University Postgraduate Medical School. Applicants should be well educated, preferably with previous experience and an interest in the biological sciences; shorthand and good typing ability. The work is interesting and varied and demands initiative and administration ability and experience in dealing with routine matters from instructions. Salary according to age and experience. Five-day week; staff canteen; social facilities; superannuation scheme. Application forms from the Secretary, Institute of Psychiatry, The Maudsley Hospital, S.E.5. (Ref. B10)

PHYSICIST

Holding a good degree and having several years experience in Industrial Research is required for Experimental and Production work in which optical problems will predominate.

The post would also suit a

MECHANICAL ENGINEER

who has interest in such problems.

Apply stating age, training and experience to:—

PERSONNEL MANAGER
BARR & STROUD LTD.
ANNIESLAND
GLASGOW, W.3.

UNIVERSITY OF READING

PROGRAMMING ASSISTANT required to help and advise users of the Reading University Elliott 803 Computer. Applicants should have a degree in (or including) mathematics, but no previous experience of computers is required. Salary (full-time) in the range £600-£800 according to qualifications. applications for a part-time post may also be considered. Applicants should write to the Assistant Bursar, The University, Reading, Berks, giving details of age, qualifications and experience, and the name of at least one referee.

SHIFT QUALITY CONTROL CHEMIST required for Sugar Refinery. Minimum qualification "O" level G.C.E. in Chemistry and Mathematics. Full training given. Applications in writing to. Chief Chemist, Manbre Sugars Ltd., Winslow Road, Hammersmith, W.6.

CHIEF STEWARD, Home School. Box C951, NEW SCIENTIST.

BEDFORDSHIRE EDUCATION COMMITTEE

Queen Eleanor's School for Girls, Langdale Road, Dunstable, opened 1959; approximate roll 390 girls.

Required as soon as possible, Laboratory Technician. Duties include maintenance of apparatus and laboratories, preparation of solutions and demonstrations of experiments in biology, chemistry and physics. There are 3 laboratories with good prep. rooms, but plans are already being prepared for a further 2 laboratories to be available in the near future. Pupils are prepared for the Advanced Level and Ordinary Level of the General Certificate of Education.

Hours 9.0 a.m. to 5.0 p.m. daily, 9.0 a.m. to 12 noon Saturdays.

Apply by letter to the Headmistress, Miss C. M. Scott, B.A., stating any qualifications or experience, and give the names of 2 referees. A stamped addressed envelope should be enclosed.

MIDDLESEX COUNTY COUNCIL

Education Dept.

LABORATORY ASSISTANT (male or female) required at Twickenham College of Technology, Egerton Road, Twickenham, Middlesex, for Applied Science Laboratory (Printing). G.C.E. "O" level in Physics or Chemistry essential. 38-hour week. Opportunities for further study. Salary Misc. III £590-£665 (max. £730 by 1965) plus London Weighting up to £40. Prescribed conditions. Application forms (s.a.e.) from Principal, returnable by 17th February. (Quote P.259 N.Sc.)

GLASSHOUSE CROPS RESEARCH INSTITUTE requires STATISTICIAN. Appointment in the Scientific Officer grade, salary £791 to £1,309. Superannuation under F.S.S.U. Candidates should be graduates, or be graduating this year, with a good honours degree (or diploma in technology) in mathematics or an appropriate science, and a qualification or experience in statistics. Further details may be obtained from the Secretary at the Institute, Worthing Road, Rustington, Littlehampton, Sussex, to whom applications, with names of three referees, must be sent before 29th February, 1964.

Recently graduated

ENGINEERS, MATHEMATICIANS OR PHYSICISTS

are invited to apply for the position of

REACTOR PHYSICS ASSISTANT

at Dungeness Nuclear Power Station, Kent

The work involved is assisting the Senior Physicists in preparation of programmes for the safe and efficient operation of the reactors, and analysis of the operating data with a view to performance optimisation.

Practical participation in the operational work during the commissioning phase will be available. Digital computers are in extensive use for handling the analytical work. In consequence a wide variety of both practical and analytical experience will accrue to the successful applicant.

Experience in Reactor Physics, Systems Analysis or Computer Programming would be useful assets but are not essential as the necessary training can be given.

Salary £1,030 - £1,325 per annum.

Applications on the standard form available from the Station Superintendent, Dungeness Power Station, Romney Marsh, Kent, should be completed and returned to him quoting Vacancy Number 32/64 to arrive by 19th February.

THE UNIVERSITY OF MANCHESTER

There are vacancies for two full-time Research Assistants in the Laboratories of the Rheumatism Research Centre. Applications are invited from Science graduates. Successful candidates will be expected to take part in studies of the experimental immuno-pathology and ultrastructure of synovial and other connective tissues. Salary according to D.S.I.R. scales for successful applicants working for a higher degree; salary range for post-doctoral candidates: £1,000 to £1,150 per annum, with membership of F.S.S.U. Duties to commence as soon as possible. Applications must be received not later than February 29, 1964, by the Registrar, the University, Manchester 13, from whom further particulars and forms of application may be obtained.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

Chemistry Department

Applications are invited for a RESEARCH ASSISTANTSHIP for work under Prof. R. M. Barrer on the surface and colloid chemistry of apatite and of materials potentially of interest as dental restoratives. Salary £1,000, rising by £50 p.a. over a 5-year period, plus £60 London Allowance, Family Allowances and F.S.S.U. benefits. Applications, giving full academic background and naming two referees, should be sent to Prof. R. M. Barrer, F.R.S., Chemistry Dept., Imperial College, Imperial Institute Road, London, S.W.7.

THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY

(Faculty of Technology in the University of Manchester)

Applications are invited for the post of Special Research Assistant in the Department of Polymer and Fibre Science to undertake research for which funds have been provided by the Department of Scientific and Industrial Research. The work is concerned with the investigation of the transfer of dyestuffs from aqueous media to the fibre phase in practical dyeing processes. Applicants should have a good honours degree in pure or applied chemistry, chemical engineering or physics and should be able to apply fundamental principles to an analysis of important industrial processes.

Salary on the scale £900 x £100 — £1,100 with membership of F.S.S.U.

Application forms may be obtained from the Registrar of the College, Sackville Street, Manchester 1, to whom completed applications should be returned by the 31st March, 1964.

THE MEDICAL RESEARCH COUNCIL require a senior animal technician (male) to take charge of a new well-equipped animal house. Applicants must possess organizing ability and be able to supervise breeding programmes and staff. Knowledge of some surgical procedures and germ free techniques an advantage as the post is associated with the production of "SPF" animals.

Salary in accordance with ATA qualifications, age and experience: plus London Weighting. Applications should be addressed to the Director, Laboratory Animals Centre, MRC Laboratories, Woodmansterne Road, Carshalton, Surrey. Telephone No. Wallington 5512.

INTERVIEWER
FOR RESEARCH PROJECT

An American Research Organisation requires a female interviewer to carry out the field work for a survey to be undertaken in the United Kingdom. The interviewer will work under the direction of a medical specialist and will be based in London but must be able to travel in the United Kingdom if required.

The survey is planned to commence early in March and is expected to last approximately six months.

Applicants should have experience of interviewing for attitude surveys and preferably have some knowledge of medical terminology. Specialist qualifications are not essential but applicants should have a good educational background and experience of interviewing.

There will be a good salary and expenses paid.

Write in complete confidence giving details of age, education, experience and present salary to:

BOX NS.463

c/o Hanway House, Clark's Place, London, E.C.2

CENTRAL ELECTRICITY GENERATING BOARD

require an

ELECTROTECHNICAL ENGINEER

to work in the Plant Design Branch of their Transmission Department.

The Branch comprises a number of specialist Groups dealing with the specification, type approval and standardisation of the main items of transmission plant for voltages up to 400 kV. The Electrotechnical Group assists those groups in special investigations over a very wide field of problems.

The successful applicant may be required to work on problems relating to insulation co-ordination, surge protection, switching surges, interference between power and telecommunication systems, and radio and television interference, etc. He should be capable of formulating requirements for special tests in the field and of analysing the results

Experience in power transmission work is essential and some experience in electronic engineering is desirable. Sound fundamental knowledge and adaptability, coupled with clear thinking, are, however, more important than detailed knowledge in these fields.

Applicants should have at least those qualifications which lead to corporate membership of the Institution of Electrical Engineers; a degree in electrical engineering will be a recommendation.

Salary on a grade within range £1,385 to £2,010 per annum, or £1,845 to £2,440 per annum according to qualifications and experience.

Applications, stating age, qualifications, experience, present position and salary to N Berryman, M.B.E., Personnel Officer (Headquarters), 24/30 Holborn, London, E.C.1, by the 17th February, 1964. (QUOTE REF. LS/30/P.

PILKINGTON BROTHERS LIMITED

Senior Physicist

to assist the Manager of the Products Application Laboratory and to carry out work on the thermal, mechanical, physico-chemical and other bulk properties of glass with particular reference to their applications in all parts of the world. The results of these studies will be discussed with sales and other departments in order to develop existing products and discuss new applications. This position offers scope for using initiative and gaining early responsibility.

Age 25-35 with honours degree and experience of experimental physics.
Ref: H.O./T.S.3.

Physicist

to lead a small team working in Products Application Laboratory on thermal and mechanical loading on glass as used in practice the influence of production and installation factors on loads and the resultant stresses and behaviour of glass.

Age 23-30, suitable for a physics graduate with a leaning to mechanical engineering
Ref. H.O./T.S.4.

Please quote above references in applying to L. P. Laidlaw, Group Staff Department, Pilkington Brothers Limited, St. Helens, Lancs.

MEDICAL RESEARCH COUNCIL'S Experimental Virus Research Unit, Institute of Virology, Church Street, Glasgow, W.1, require graduate either for post as BIOPHYSICIST for research in the molecular biology of viruses (the post involves responsibility for an electronmicroscope and ancillary equipment, for which prior experience is an advantage, but the research will not be confined to electron microscopy), or as ELECTRON-MICROSCOPIST to take charge of electron-microscope and ancillary equipment. Previous experience in a wide range of techniques essential. Either post involves some postgraduate and undergraduate teaching and the possibility of an honorary university appointment. Salary according to age, qualifications and experience; superannuation provision. Applications with full details and names of two professional referees to Director at above address.

CLARE HALL HOSPITAL

South Mimms, Barnet, Herts

(381 beds for Diseases of the Chest)

BIOCHEMIST (Senior Grade), non-resident, required. Candidates should be qualified in accordance with Ministry of Health requirements. Whitley Council salary scale plus London Weighting. Applications to Chairman, Medical Advisory Committee.

Taking 'A' levels this year?

Are you interested in a flying or technical career? Then look to the future. If you have the ambition and ability to get to the top, consider a cadetship at one of the R.A.F. Colleges, Cranwell or Henlow. It could give you the necessary background for one of the most progressive, interesting and challenging careers open to you—a permanent commission in the Royal Air Force.

Cranwell

Teaches flying—and more

A 3-year cadetship at Cranwell prepares you for a future that can take you from Pilot Officer to Commander-in-Chief. When you leave Cranwell you will fly as an aircrew officer at an operational station. A few years later you could be commanding a flight or squadron, an appointment that combines flying with executive responsibility: Cranwell trains you in the essential art of man-management. You could be appointed to NATO or SEATO committees or to the Staff of an Embassy abroad: Cranwell prepares you with lectures on history, political theory and international affairs. At 40 you could be a Group Captain in charge of a base as big as a town—responsible for the work and welfare of 2,000 men: Cranwell subjects include the theory of organisation and administration. A cadetship at Cranwell gives you a chance to develop all your talents to the full and the opportunity to prepare yourself for very high appointments later on.

Henlow

Engineering training to degree level

Just as Cranwell teaches more than flying, so Henlow teaches more than engineering. A Henlow cadetship can lead to the highest ranks in the Technical Branch and appointments like Senior Technical Staff Officer in a Command Headquarters, a position that demands an incisive mind capable of planning at the highest level.

At Henlow you can read for the Dip. Tech. (Engineering) which is equivalent to a University degree. This gives you the necessary technical knowledge you will particularly need during the early years of your commission when you will be directly concerned with the fighting efficiency of the Service—officers of the Technical Branch are engaged in the maintenance, research and development of all the equipment used by the R.A.F.—aircraft, guided missiles, electronic equipment, radar. At the same time you attend lectures in strategy, management, international affairs—the subjects you will need when you reach the higher executive appointments.

Applying for a Cadetship

During your training as an officer cadet at Cranwell or Henlow you will be well paid—and you will enjoy a high standard of living in the College Mess. To be selected for a cadetship you must be intelligent and a potential leader with a strong sense of responsibility. You must be between 17½ and 19½ on entry.

For Cranwell you must have G.C.E. (or equivalent) in English language, mathematics, science or a second language and two other acceptable subjects. Two subjects must be at 'A' level.

For Henlow you must have G.C.E. (or equivalent) in English language, mathematics (pure and applied), physics, chemistry, and two other subjects. Mathematics and physics must be at 'A' level.

R.A.F. Scholarships worth up to £260 a year are available for boys over 15 years 8 months who wish to stay on at their own schools until they are qualified to enter Cranwell or Henlow.

Next entry to Henlow and Cranwell: Autumn 1964. For full details of R.A.F. cadetships and R.A.F. scholarships write at once to Group Captain J. W. Allan, D.S.O., D.F.C., A.F.C., R.A.F., Air Ministry, (NB 109A), Adastral House, London WC1. Give your date of birth, G.C.E. subjects which you hold or expect to gain, and state which college most interests you.

The Royal Air Force

PHYSICIST

The United Kingdom Atomic Energy Authority invite applications from graduates with good honours degrees in Physics who wish to work in the field of radiological protection.

The successful applicant will be required to work on a wide variety of problems related to the measurement and radiological dose and dose rates of mixed neutron and gamma radiation in steady and rapidly varying fields. Formal training will be given if necessary. Experience in solid state physics, radiation physics or physical electronics would be an advantage, but is not essential.

Starting salary will be assessed within the range of £850 to £1,900, depending on age and experience. A house, or substantial assistance with house purchase, will be available to married officers living beyond normal daily travelling distance.

Please write to:

THE SENIOR RECRUITMENT OFFICER (Ref. 3243/215)
A.W.R.E., ALDERMASTON, BERKS.

JOSEPH LUCAS LIMITED
Group Research Centre
MARSTON GREEN, BIRMINGHAM

A Young Graduate

in Mechanical Engineering or Metallurgy, preferably with a few years industrial experience, is required to take part in Research and Development work on bearings (including high speed air bearings) in connection with specific industrial projects. Interest in other aspects of friction, wear and lubrication research is encouraged.

Applications giving full details should be forwarded to the:

Personnel Manager
JOSEPH LUCAS LIMITED
Great King Street
Birmingham, 19
quoting reference PM/GR/730

UNIVERSITY OF BIRMINGHAM
Department of Physics

Applications are invited for the following posts in the Department:

(a) Senior Research Associates, Research Associates or Research Assistants for research group working on bubble chamber data analysis. Successful candidates may work in fast counter circuitry and logic, advanced data analysis machines or data processing and programming. Research in progress using the Birmingham, National Institute and C.E.R.N. (Geneva) accelerators. Applicants should be graduates in Electrical Engineering or Physics and have postgraduate experience. Applications to register for a higher degree will be considered.

(b) Research Assistant, Technical Officer or Senior Technician for work with beam injection, beam engineering and counters. Practical experience in one of the following fields is desirable, high voltage low current work; electronics; high vacuum techniques; general nuclear physics instrumentation.

Salary range: Senior Research Associate £1,100-£1,490 with F.S.S.U., Research Associate £825-£1,100, Research Assistant £675-£825, Technical Officer £1,000-£1,400, Senior Technician £810-£1,010.

Applications should be sent by (15th February, 1964) to the Administrative Officer, Department of Physics, The University, Birmingham 15, giving full details of career and qualifications.

NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING
(University of Reading)

Assistant Experimental Officer required for work on the assessment of the flavour of milk and milk products, using new techniques including gas chromatography. Candidates should be familiar with elementary chemical techniques and should possess pass degree or H.N.C., or if under 22, G.C.E. "A" level in 2 subjects. Starting salary within range £490 (at 18) to £858 (at 26) in scale to £1,053; pension scheme, five day week. Applications with the names of two referees to Secretary, N.I.R.D., Shinfield, Reading. Quote ref. 63/NS/17.

LABORATORY TECHNICIAN to specialise in spectrographic analysis for metallurgical laboratory in London. Age 18/21. O-level G.C.E. physics, maths and/or Chemistry and preferably experience in scientific work. 5-day week. Write: British Non-Ferrous Metals Research Association (ref. MEW), Euston Street, London, N.W.1.

THE ROYAL COLLEGE OF SCIENCE AND TECHNOLOGY, GLASGOW
Department of Natural Philosophy

Applications are invited from experimental and theoretical physicists with research experience in the field of quantum electronics (lasers, transistors), plasma physics or solid state physics for LECTURESHIPS and ASSISTANT LECTURESHIPS on the salary scales £1,250-£2,150 and £1,000-£1,150 respectively, together with F.S.S.U. benefits and family allowances.

Application forms may be obtained from the Secretary, George Street, C.1 and should be lodged by 6th April, 1964.

UNIVERSITY OF READING

Research Demonstrator in Department of Microbiology

Applications are invited for one or more posts as Research Demonstrator in the Department of Microbiology, to be appointed from 1st October, 1964. Applicants should have qualifications in Microbiology, Bacteriology, Biochemistry or related subjects. A Demonstrator will be expected to demonstrate in practical classes to a maximum of eight hours per week during term and to engage in research. There will be opportunity to register for a higher degree (M.Sc., Ph.D.). The salary is at the rate of £500 x £25 — £550 p.a. Further particulars may be obtained from the Professor of Microbiology, to whom preliminary correspondence should be sent not later than 16th March.

UNIVERSITY OF DURHAM
Physics Department, South Road, Durham

The research interests of this department include atmospheric physics, cosmic rays, experimental and theoretical high energy nuclear physics, gas discharges and the magnetic properties of rare earth elements and alloys. Students interested in research work in any of the above subjects, which may lead to a higher degree, should apply to Professor B. H. Bransden for Theoretical Physics, and Professor G. D. Rochester, F.R.S., for Experimental Physics, by 1st March, 1964.

NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING
(University of Reading)

The Chemistry Department requires an Assistant Experimental Officer to help with research work on the metabolism of the cow in relation to the secretion of milk constituents, particularly protein, and on the characterisation of differences between cows in the composition of their milk. Candidates should be interested in biochemical analysis and hold a pass degree, H.N.C., or equivalent. Starting salary according to age (e.g. £691 at age 22, and £858 at age 26) in scale to £1053. Pension scheme. Applications, including the names of two referees, to the Secretary, N.I.R.D., Shinfield, Nr. Reading, quoting ref. 64/NS/7.

BRADFORD INSTITUTE OF TECHNOLOGY
Department of Textile Industries

Applications are invited from Organic Chemists and Biochemists for the post of

Research Assistant

to undertake work on polysaccharides of intervertebral discs and connective tissues.

Salary up to £700 per annum depending upon experience.

Facilities available to work for higher degree.

Further particulars may be obtained from:— The Secretary, The Royal Infirmary, Bradford 9, and from The Registrar, Bradford Institute of Technology, Bradford 7.

BIO-MEDICAL ENGINEERING

Applications are invited for posts in the Medical Electronics Department of St. Thomas's Hospital. The department is concerned with the application of electronic and electromechanical instrumentation techniques in the field of Bio-medical research. Applicants should have had practical experience in the development of electronic circuits or electromechanical devices and an engineering degree or equivalent qualifications would be an advantage. Apply Personnel Officer, St. Thomas's Hospital, London, S.E.1.

QUALIFIED PAINT TECHNOLOGIST required with some years experience of formulating industrial finishes. The successful applicant will lead a section of the laboratory concerned with varied and interesting development work. Commencing salary up to £1,200 and good prospects of advancement offered to young chemist (23-30 years) with initiative and plenty of drive. Location North West Kent. Reply to Chief Chemist, Box C950, New Scientist.

INSTRUMENTATION ENGINEER, preferably with at least H.N.C. or equivalent qualifications in electronics, electrical engineering or physics. Responsibilities will include development of practical instruments from new ideas. Age 20-30. Apply: Secretary/RE, British Non-Ferrous Metals Research Association, Euston Street, N.W.1.

SOLID STATE PHYSICS
SEMI-CONDUCTORS AND MAGNETICS
SPACE RESEARCH
COMMUNICATION BY SATELLITE
opportunities
MICROWAVE TRANSMISSIONS
MATHEMATICS AND COMPUTER TECHNOLOGY
ELECTRONIC CIRCUITRY AND SWITCHING
TRANSOCEANIC TELEPHONY
REPEATERS AND WORLD CABLE
ANALYSIS AND SYNTHESIS OF SPEECH
GPO

Progressive opportunities for science and engineering graduates with university degree or diploma in technology

The young scientist or engineer entering the Post Office of today has the most attractive opportunities ever known in this important public service.

RESEARCH Our research laboratories need electrical engineers and physicists to work in small teams on: low-noise receivers (e.g., masers), active and passive networks, millimicrosecond techniques, thermionics, ferromagnetism, transistor technology and applications, speech and hearing, character recognition, submarine cable systems (very reliable amplifiers and fault-detecting equipment), all-electronic telephone exchanges, studies using very low temperatures and high vacua. There are also posts for mathematicians (e.g., to work on electro-magnetic and circuit theory and statistics) and for chemists (e.g., to work on corrosion, plastics, semi-conductors).

DEVELOPMENT The telephone system already connects nearly nine million instruments. This number will probably double in the next twenty years. Engineers with drive and vision are needed to direct its development on the most modern lines.

VACANCIES There are some 35 vacancies for engineers or scientists with First or Second Class Honours degrees or equivalent Dip.Tech. Graduates and those in their finals year are invited to write *NOW* giving details of their qualifications and field of interest, with the usual personal details to:

THE DIRECTOR OF RESEARCH
RECRUITMENT (NS)
POST OFFICE RESEARCH STATION,
DOLLIS HILL, LONDON, N.W.2.

WOODALL-DUCKHAM

CONSTRUCTION COMPANY LTD.,

Require

QUALIFIED CHEMICAL ENGINEERS

FOR A PROJECTS DIVISION OF THEIR SALES DEPARTMENT

Qualifications: Degree in Chemical Engineering and/or membership of Institution of Chemical Engineers.

Previous occupation in a responsible position in industry.

Ability to carry out and co-ordinate process design calculations for complete process streams end to assist in the development of large industrial projects to the Contract stage.

Some experience on the design and rating of heat exchangers also advantageous.

Successful applicants, aged preferably under 35, would join a team engaged on the design of high pressure gasification processes and vessels for the Gas Industry and fertiliser market.

The offices of the Company are at present in London, but during the late summer of 1964 will be moved to new premises at Crawley (Sussex).

The Company operates a Pension Scheme and Life Assurance Scheme and provides excellent working conditions.

Salary will depend on age and experience.

Apply in confidence, with full particulars as to age, education, experience and salary required, to:—

Personnel Officer
WOODALL-DUCKHAM HOUSE
63-77, Brompton Road, London, S.W.3

THE NATURAL RUBBER PRODUCERS' RESEARCH ASSOCIATION requires a LABORATORY ASSISTANT with an interest in BOTANY for research work on rubber producing plants.

Previous scientific experience with plant materials would be an advantage, but is not essential.

Minimum qualifications: Two passes at "A" level G.C.E. including Botany or Biology.

Salary in the range £377 p.a. (aged 16 on 1st January, 1964), to £024 p.a. plus education bonuses of £39 p.a. for four or more appropriate G.C.E. "O" level subjects and £13 p.a. for each "A" level G.C.E. scientific subject (to a maximum of £39).

Every encouragement and financial assistance given for part-time study leading to a degree or equivalent qualification.

Applications to the Director of Research, N.R.P.R.A., 48-56 Tewin Road, Welwyn Garden City, Hertfordshire.

CHEMIST (H.N.C. or equivalent), with experience of paints or inks, required for interesting development work in a factory laboratory near Croydon. Salary, which is progressive, commences between £858 and £1,000. Write to Chief Chemist, Box C948, New Scientist.

UNIVERSITY OF NOTTINGHAM

Department of Production Engineering

Applications are invited for a RESEARCH ASSISTANTSHIP to work on problems associated with the mechanisation of assembly processes. Candidates should possess a degree in Engineering, Physics or Mathematics or its equivalent, with appropriate research or industrial experience. Initial salary within the range £1,250 to £1,000 p.a. according to qualifications and experience plus superannuation benefits and children's allowance. Conditions of appointment and form of application, which should be returned by 22nd February, from the Registrar.

A SENIOR WOMAN LABORATORY ASSISTANT is required by Allan & Hanburys Ltd., Ware, Herts., for microbiological assay work on antibiotics and vitamins. Applicants should have at least three years' experience of this type of work. Good terms and conditions of employment are offered and applications should be addressed to the Personnel Officer.

CHEMISTS AND PHYSICISTS

POROUS PLASTICS LIMITED

A wholly-owned subsidiary of the Chloride Electrical Storage Co. Ltd., have pioneered the development and manufacture of a wide range of microporous products. These have the unique property of impermeability to water while being permeable to water vapour.

Applications are invited from men 24-28 years who have graduated in Chemistry or Physics and have Industrial research or development experience. This should be preferably but not necessarily in Polymer chemistry, Plastics technology, or Textile technology.

Those appointed will be required to lead teams of technicians in the development of new products up to the stage of full-scale production in the following fields:

Clothing
Footwear
Upholstery

The work calls for initiative, resourcefulness and leadership. Opportunities for advancement are good.

Please write in confidence, giving full details, to:

Personnal Manager, Porous Plastics Ltd., Dagenham Dock, Essex

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WESTERN REGIONAL HOSPITAL BOARD, SCOTLAND

Assistant Regional Physicist

The Board intend shortly to appoint a second Assistant Regional Physicist. The person appointed will have duties in the Regional Physics Department; this is an active and expanding laboratory with a staff of more than 60 people. The person appointed will be responsible for the formulation of scientific advice to hospital authorities and for the supervision of members of the department's staff participating in clinical research projects. The work is hard, requiring a wide knowledge of classical and contemporary physics allied to considerable organising ability.

Applicants should have good academic qualifications (perferably including a higher degree) and experience in one or more of the following fields:

(a) research and development in industry or a government establishment
(b) application of physics to problems arising in clinical research
(c) design and development of scientific instruments

Further particulars may be obtained from the Regional Physicist, Regional Physics Department, 9-13 West Graham Street, Glasgow, C.4.

Salary will be on the scale £1,925-£2,520 with superannuation benefits; six weeks annual leave. Applications, giving the names of two referees should be sent before 29th February, 1964, to the Secretary, Western Regional Hospital Board, 351 Sauchiehall Street, Glasgow, C.2.

JOHNSON, MATTHEY & CO. LIMITED

are seeking to appoint a

PHYSICAL METALLURGIST

We need a Senior Physical Metallurgist at our Research Laboratories in the Exhibition Grounds, Wembley, Middlesex, to lead a group working on high temperature materials and other metals and alloys of importance to the Company. Previous experience in this field would be useful, but of more importance is a sound scientific approach, coupled with enthusiasm and drive. In return we offer good facilities for research in a pleasant environment and excellent conditions of service.

If you are interested in this appointment, you are invited to write to Dr. Hunt, Director of Research, at 78 Hatton Garden, London, E.C.1, who will be pleased to give you further details and to arrange, if you wish, for you to visit the Company to discuss the vacancy and our plans for the future.

BEDFORDSHIRE EDUCATION COMMITTEE

Redborne County Secondary School, Ampthill

Required as soon as possible, qualified laboratory technician. Duties include maintenance of apparatus and laboratories, preparation of solutions and demonstration experiments in Biology, Chemistry and Physics. Salary £280 per annum at 16 years, £485 per annum at 22 years, £520 per annum at 23 years, rising to an eventual maximum of £725 per annum. At age 18 superannuation under Local Government Superannuation Scheme. Hours 9 a.m. to 5 p.m. daily, 9 a.m. to 12 noon Saturdays. Apply by letter to the Headmaster stating any qualifications or experience, giving names of two referees who can speak with knowledge of the candidate. Candidates with no previous experience of this kind of work will be considered if they are adaptable.

UNIVERSITY OF READING

Research Demonstrators required in the Department of Horticulture to assist with practical classes in horticulture, plant physiology or crop protection and carry out research in one of those subjects. Good degree in botany or horticulture essential. Applications to Professor O. V. S. Heath, F.R.S., University of Reading Horticultural Research Laboratories, Shinfield Grange, Reading.

PILKINGTONS
the greatest name in the world of glass

CHEMISTS:

for work on melting problems, structural chemistry of glass and physical chemistry at glass surfaces.

PHYSICISTS:

for fundamental and applied research in solid state, reaction kinetics, thermo-dynamics, spectroscopy, X-ray techniques and electronics.

MATHEMATICIANS:

for operational research, computer investigations, work study, quality control and statistics.

MECHANICAL ENGINEERS:

for process and product development on existing plant, design and operation of pilot plant in Technical Development, and for a two-year Post-Graduate Training Course.

TECHNOLOGISTS:

in Fuel and Glass for Technical Development and Production Departments.

Graduates are invited to apply to:

L. P. Laidlaw, Personnel Officer (Technical Staff)
Pilkington Brothers Limited, Grove Street
St. Helens, Lancashire

THE RADIOCHEMICAL CENTRE

of the United Kingdom Atomic Energy Authority at Amersham

has a vacancy for a

SENIOR SCIENTIFIC ASSISTANT

to take charge of the production of an important radio-pharmaceutical product

The duties involve supervision of a small team engaged on the production of an iodinated human protein for medical use under strictly controlled conditions. The work includes the handling of radioactive materials, testing of media and sterility testing, and the keeping of accurate records.

This position demands a high sense or responsibility. Besides a basic scientific background experience of sterile techniques is desirable, but previous knowledge of radioactive isotopes is not essential. Minimum academic qualifications are O.C.E. (Ordinary Levels) in four subjects, including English Language and either Mathematics or a Science subject, or equivalent qualifications Applicants should be at least 27 years old.

Salary will be assessed within the scale £930-£1,245 per annum. Contributory superannuation. Housing scheme. Send postcard for application form to:

Personnel Officer,
The Radiochemical Centre,
Amersham, Bucks.
quoting reference 1/64/215

ST. GEORGE'S HOSPITAL
Hyde Park Corner, London, S.W.1
Physics Department

An electronics technician is required for the Physics Department Workshops, to work mainly in the new Pacemaker Unit that is being established (by the Cardiac Department) at Tooting Grove. The applicant should be well experienced in the field of general electronics and especially solid state devices. Some knowledge of physiology and mechanics would be an advantage The person appointed will have considerable contact with patients and although working as part of a team will be expected from time to time to take responsibility for certain aspects of the work with the minimum of supervision. Salary, according to experience, in the range £800-£1,000

Applications stating age, nationality and experience together with the names and addresses of two referees to the undersigned.

J. HAMILTON LOWE,
Deputy Secretary

BIRKBECK COLLEGE
(University of London)
Department of Chemistry

Applications are invited for two posts of non-graduate research assistant in spectroscopy. Salary scale: £615-£860 p.a. Full training given but a pass in chemistry or physics at G.C.E "A" level and/or some experience in electronics would be an advantage Consideration will be given to making one of the appointments near the top of the scale. Further particulars may be obtained from the Administrative Assistant (Staff), Birkbeck College, Malet Street, London, W.C.1, to whom applications should be sent by 24th February, 1964

PILKINGTON BROTHERS LIMITED
Refractories Technologist

to work in the Refractories Section of the Company's Research Laboratories at Lathom near Ormskirk, primarily on the physical testing of refractories at high temperatures and the design of the necessary equipment.

Age 25-3a with a good university degree and experience in the physical testing of refractories or ceramics Some knowledge of electrical and electronic equipment would be an advantage.

Salary will be in a range which can rise to £2,000 Please quote RES G.t in applying to L. P Laidlaw, Group Staff Dept., Pilkington Brothers Limited, St. Helens, Lancashire.

LIBRARY ASSISTANT required, primarily to assist in the compilation of card indexes. Some knowledge of languages and of chemistry (e.g. to O level G C E.) an advantage. Previous experience of library work not essential but the position offers a good opening for anyone interested in embarking on a career in this field. Applicants should apply in writing to the Paint Research Station, Waldegrave Road, Teddington, Middlesex.

JUNIOR TECHNICIAN for work using radioactive isotopes. Previous experience desirable but not essential. Salary £330-£670 p.a. Applications to the Secretary, Institute of Nuclear Medicine, Middlesex Hospital Medical School, London, W.1.

BP
RESEARCH VACANCIES

BP has vacancies for CHEMISTS and PHYSICISTS in the Basic Research Division at the Research Centre, Sunbury-on Thames. The posts involve Fundamental and Exploratory work, using advanced techniques, on catalysis, organic synthesis, mechanisms of reactions, inorganic structures and complexes etc. The Division is soon to be provided with new laboratories and has equipment or access to service groups for mass spectrometry (MS9), ESR, NMR, advanced GLC etc. Applicants should have a good honours degree or equivalent in chemistry or physics. Salary according to age, qualifications and experience. Non-contributory Pension Fund. Write giving brief details and quoting reference RCB to Box 7508, c/o Hanway House, Clark's Place, E.C.2.

EDUCATION

ROYAL COLLEGE OF ADVANCED TECHNOLOGY, SALFORD
Department of Pure and Applied Physics

Applications are invited for academic posts at all levels in the above department of the College which, following the recommendations of the Robbins Report on Higher Education, is expected to become a University Institution in the near future.

The department is concerned with Sandwich Courses for the Diploma in Technology, courses for B.Sc. (London) and courses in Nuclear Power Technology and in Acoustics. The development of research is encouraged.

Applicants may also be considered for appointment to Wardenship or Assistant Wardenship at the College Halls of Residence due to open later in 1964.

Application forms and further particulars may be obtained from the Secretary, Royal College of Advanced Technology, Salford, to whom completed applications should be returned as soon as possible, quoting reference P/14.

PERSONAL

Scientific data in Microform

Including theses on Metallurgy, Chemistry, Physics, Engineering and Biology; Out of Print Classics on Botany and Mycology; Atomic Energy Reports; Aeronautical Reports; O.S.I R. reports. Available on microfiche, card, film or in xerox editions. Catalogues and details from Micro Methods Limited, East Ardsley, Wakefield, Yorkshire.

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278/282 High Holborn, W.C.1

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FURNASCOTE for speedy, low-cost repair of refractories Keeps your furnaces in action. Gives gas tight, acid-resisting, monolithic coatings Write: FURNASCOTE LTD., SOUTHAMPTON Tel. Locksheath 3372.

FELLOWSHIPS, GRANTS AND SCHOLARSHIPS

THE NUFFIELD FOUNDATION

Biological Scholarships and Bursaries

The Nuffield Foundation, as part of its programme for the advancement of biological studies, is prepared to offer for the academic year 1964-65 a limited number of scholarships and bursaries to enable persons who have:—

(a) graduated in physics, chemistry, mathematics or engineering, but who have had no training in a biological subject, to receive such training in biology as will enable them in due course to undertake an academic career in the United Kingdom in the biological sciences.

(b) graduated in biology, to receive such training in appropriate aspects of physics, chemistry and mathematics (in all or any of these subjects) as will enable them, thus additionally equipped, to undertake an academic career in the biological sciences in the United Kingdom.

The Scholarships, which are the senior awards, are intended for persons who have already undertaken some post-graduate research in their own subject. The Bursaries are intended to enable those who have recently graduated. In the case of both scholars and bursars, the Foundation will pay the cost of university and/or college fees, in addition to a maintenance award. Graduates of universities in the United Kingdom, of either sex and preferably between the ages of 22 and 35, are eligible to apply.

Applications for awards in 1964 must be received before April 1st, 1964, by the Director, The Nuffield Foundation, Nuffield Lodge, Regent's Park, London, N.W.1, from whom full particulars and application forms can be obtained.

L. FARRER-BROWN,
Director of the Nuffield Foundation

HARRIS COLLEGE, PRESTON

Principal: H. Wilkinson, M.Sc.Tech., Ph.D., A.Inst.P.

Department of Chemistry and Biology

Research Studentships

Applications are invited from suitably qualified graduates for two Research Studentships each of £500 per annum tenable for two years or more, subject to annual review. The opportunity of augmenting this by a limited amount of part time teaching may arise.

Applicants may choose any one of the following fields in which to work:— Surface chemistry, radiation chemistry, kinetics, synthetic organic chemistry.

Suitable applicants will be interviewed.

Application forms may be obtained from the Head of Department, Department of Chemistry and Biology, Harris College, Corporation Street, Preston.

W. R. TUSON,
Clerk to the Harris Council

NATIONAL VEGETABLE RESEARCH STATION

"Heinz" Scholarship

Applications are invited from honours graduates wishing to pursue further studies and obtain training in research in any one of the following lines of research in progress at the Station: Plant Breeding, Chemistry, Plant Physiology, Irrigation, Plant Pathology, Ecology and Control of Weeds, Biometry. The scholarship of the value of £500 per annum is tenable for two years, with possible extension for one year. Awards will date from 1st October, 1964. Closing date for applications 31st March, 1964. Further information from the Secretary, National Vegetable Research Station, Wellesbourne, Warwick.

THE UNIVERSITY OF SOUTHAMPTON

Physics Department

Applications are invited for a Research Fellowship to take part in experiments on primary cosmic gamma radiation, particularly its direction of incidence, by flying spark chambers and associated equipment in balloons and satellites. Three years post-graduate research experience essential. Salary £1,100. F.S.S.U. Enquiries and applications should be sent to Professor G. W. Hutchinson, Department of Physics, The University of Southampton.

QUEEN MARY COLLEGE
(University of London)

A.E.I. Fellowship

The Governors of Queen Mary College invite applications for an A.E.I. Fellowship in the Department of Electrical Engineering tenable from April, 1964. The Fellowship is tenable for two years in the first instance and may be extended for a third. The facilities of the Department are specially good for research into electrical properties of materials, and high-voltage and heavy current engineering. The successful applicant will be expected to work in one of these fields. Candidates should possess a good University degree in Electrical Engineering or Physics and have had industrial or research experience. The salary will be not less than £900 per annum with F.S.S.U. participation. Application forms, obtainable from the Registrar, Queen Mary College, Mile End Road, London, E.1, to be returned before 24th February, 1964.

THE UNIVERSITY OF LEEDS

Department of Applied Mineral Sciences in The Houldsworth School of Applied Science

The Shell International Petroleum Company has agreed to offer two scholarships, value £470 per annum less fees to enable studies to be pursued in Applied Mineral Sciences, leading to the degree of B.Sc., with honours and, thereafter, is prepared to consider the scholars for a career with the Company.

Applications are invited from candidates who qualify, or who are likely to qualify, for University entry for the 1964/65 session. G.C.E. "A" level requirements are two or three from Mathematics, Physics, Chemistry, Geology.

Further details from: The Secretary, Department of Applied Mineral Sciences, The University, Leeds 2.

KING'S COLLEGE, CAMBRIDGE

Stringer Fellowship

The Governing Body of King's College invites applications for a Fellowship in Natural Sciences. The holder of this Fellowship will be called the Stringer Fellow.

Candidates must be made members of the University of Cambridge and under thirty years of age on 31st March, 1964, but allowance may be made for any period of national service, illness or professional training. Applications should reach the Provost by 13th March, 1964.

For further particulars see the "University Reporter", Cambridge, or apply by letter to: The Assistant Bursar, King's College, Cambridge.

LECTURES, MEETINGS AND COURSES

UNIVERSITY OF WALES

Applications are invited for SENIOR FELLOWSHIPS of the University of Wales, open to graduates of any University, and intended for advanced research without limitation of subject. The Fellowships, normally tenable for two years from October 1, 1964, may be held at any of the four constituent Colleges or the Welsh National School of Medicine. The possession of a research degree will normally be a minimum requirement for appointment. Salary £1,000 a year, together with F.S.S.U. benefits and family allowances.

Further particulars may be obtained from the Registrar of the University of Wales, University Registry, Cathays Park, Cardiff, by whom applications must be received not later than March 1, 1964.

UNIVERSITY CORRESPONDENCE COLLEGE

Postal tuition for LONDON UNIVERSITY Entrance requirements and DEGREES (B.Sc., B.Sc. (Econ.), B.A., LL.B., etc), GENERAL CERTIFICATE OF EDUCATION (all Examining Boards, Ordinary and Advanced Levels), Diploma in Mathematics, and many other examinations. Moderate fees. Free Prospectus from the Registrar, 28 Burlington House, Cambridge.

UNIVERSITY COLLEGE OF NORTH WALES

Department of Zoology

Advanced Course in Embryology and Mammalian Reproduction

Applications are invited from graduates with an honours degree in Zoology, Physiology or Anatomy or with a Medical or Veterinary qualification. The course will last twelve months and lead by examination and dissertation to the M.Sc. degree. The course has been approved by the D.S.I.R. for Advanced Course Studentships.

The course is designed to cover the principles of vertebrate embryology, descriptive and experimental, with particular reference to mammals, placentation, the physiology of foetal life, transmission of immunity, oestrous cycle, reproduction of the male mammal, sterility and prenatal mortality.

The course will commence in October 1964, and will lead to an examination in June 1965, and the presentation of a dissertation in September 1965.

Applicants should write immediately to the Registrar, University College of North Wales, Bangor, Caernarvonshire, from whom application forms and further particulars may be obtained.

HATFIELD COLLEGE OF TECHNOLOGY

Hertfordshire

Seventh Visiting Mathematicians Lectureship

Programme

MATHEMATICAL PROGRAMMING

DR S VAJDA

Admiralty Research Laboratory, Teddington

Tuesday, 18th February, 1964

10.00 a.m.-5.00 p.m.

Subjects:

QUADRATIC PROGRAMMING AND NON-LINEAR PROGRAMMING; INTEGER PROGRAMMING; APPLICATIONS OF GRAPH THEORY—Discussion.

Inclusive Fee: £2

Details from Academic Registrar

UNIVERSITY OF WALES

Applications are invited for IMPERIAL CHEMICAL INDUSTRIES RESEARCH FELLOWSHIPS in Chemistry, Physics, Metallurgy, Engineering, Geology, Agricultural Science or related subjects. The Fellowships, normally tenable for three years from October 1, 1964, may be held at any of the four constituent Colleges or the Welsh National School of Medicine. The salary, which will depend upon qualifications and experience, will normally be within the range £1,000-£1,200 per annum together with F.S.S.U. benefits and family allowances, but awards up to £1,500 per annum may be made in the case of engineers and technologists where industrial experience or other special circumstances warrant it.

Further particulars may be obtained from the Registrar of the University of Wales, University Registry, Cathays Park, Cardiff, by whom applications must be received not later than March 1, 1964.

UNIVERSITY OF WALES

University College of Swansea

Department of Applied Mathematics

Applications are invited for admission to a one-year postgraduate course in CONTINUUM MECHANICS, beginning in October, 1964, and leading to the degree of M.Sc. by examination and dissertation. Further particulars may be obtained from Professor J. G. Oldroyd, University College of Swansea, Singleton Park, Swansea.

THE UNIVERSITY OF LEEDS

M.Sc. Course in

Electronic Computation

The Electronic Computing Laboratory will be introducing a course lasting one calendar year in October, 1964, leading to the degree of M.Sc. by examination.

Further particulars can be obtained from: The Director, Computing Laboratory, The University, LEEDS 2.

UNITED KINGDOM ATOMIC ENERGY AUTHORITY
ISOTOPE SCHOOL

Courses in 1964	**Commencing**
General Isotope Courses (4 weeks)	13th April 22nd June
Radiological Protection (1 week)	17th February 15th June 2nd November
Radioisotopes in Non-Destructive Testing (1 week)	2nd March
Autoradiography for Biologists (1 week)	18th March
Isotope Course for Science Teachers (1 week)	8th April 7th September
Radioisotope Methods in Chemistry (3 weeks)	25th May
Radioisotopes Course with Special Reference to Medicine (3 weeks followed by 2 weeks hospital visits)	14th September
Measurement of Radioactivity (3 weeks)	12th October
General Isotope Course with Special Reference to Biochemistry (4 weeks)	18th November

A Syllabus giving details of the topics covered by the courses is available. Forms of application for attendance may be obtained from the Isotope School. The number of students who can be accommodated on a course is limited and early application is advised.

Isotope School,
Wantage Research Laboratory (A.E.R.E.),
WANTAGE,
Berkshire.
Telephone: Wantage 800, Ex: 20

ROYAL COLLEGE OF ADVANCED TECHNOLOGY, SALFORD

Department of Electrical Engineering

One-year Postgraduate Course in Instrumentation and Control

A full-time postgraduate course of three terms' duration (October-June) will be available from October 1964. The aim of the course is to provide a thorough understanding of the basic theory and practice of control engineering, with particular emphasis on the application of electronics in this field. The main subjects covered in the course are:—

Electrical Networks and Feedback Systems
Electronic Devices and Circuits
Electrical Transducers and Measuring Systems
Control System Design
Computing Methods.

On satisfactory completion of the course, which includes a minor research project, students will be eligible for the College Diploma in Advanced Studies, awarded on the results of an examination and thesis.

For acceptance on the course applicants must hold a qualification of degree level in engineering or applied science.

Preliminary application should be made to the Head of the Department of Electrical Engineering as soon as possible, when further particulars will be supplied.

GUY'S HOSPITAL MEDICAL SCHOOL, LONDON, S.E.1

M.Sc. in Radiation Biology and Radiation Physics

The next two-year full-time course leading to this degree of the University of London will begin in October, 1964. The course is open to selected graduates in science and medicine.

In the first year, those who graduated in biological science or medicine will study basic and radiation physics; graduates in the physical sciences will study the principles of modern biology. In the second year the course in advanced radiation biology is common to all students.

The fee is £90 per year. A limited number of studentships may be available; early application is necessary.

Further details can be obtained from the Secretary, Physics Department, Guy's Hospital Medical School, London Bridge, S.E.1.

Gillette

offer a Sandwich Course in

PRODUCTION ENGINEERING

DURATION OF COURSE: Approximately 4 years starting from September, 1964.

AGE LIMITS: Between 18 and 21 years of age as at 1st September, 1964.

ENTRY QUALIFICATIONS: Either (a) good G.C.E. "A" level passes in Mathematics and at least one but preferably two Sciences, together with "O" level passes in three other subjects, one of which is English, or (b) O.N.C. or O.N.D. at a high standard.

PROGRAMME OF TRAINING: After a short period of induction training there will follow alternating six monthly periods of theoretical and practical training which will be carried out at the Brunel College of Advanced Technology, Acton, and at the Gillette Factory, Isleworth.

ACADEMIC AWARDS: Successful Apprentices will qualify for the Diploma in Technology (Production Technology) which is the equivalent of an Honours Degree at a British University. This Diploma will give complete exemption from the examination for corporate membership of the Institution of Production Engineers.

SALARIES AND ALLOWANCES: Tuition fees are paid by the Company and allowances are made for text books. The student will be paid by the Company during both industry and college periods within a scale ranging from approximately £490 per annum during the induction period to £700 per annum during the last six months of the Course.

APPLICATIONS can be made in anticipation of Summer 1964 examination results and should be addressed to the Personnel Controller, Gillette Industries Limited, Great West Road, Isleworth, Middlesex, quoting reference Number EAS/300.

Applications must be received on or before the 1st March, 1964.

WOLVERHAMPTON AND STAFFORDSHIRE COLLEGE OF TECHNOLOGY

Symposium on

Recent Developments in

PROTECTIVE COATINGS

Thursday and Friday,
20th and 21st February, 1964

Further details and Application Forms from the Head of the Department of Applied Science.

POSTAL TUITION

for G.C.E. (O and A levels), London Univ., B.Sc., B.A., B.Sc.(Econ.), LL.B., and for professional examinations. Prospectus (mention exam) from E. W. Shaw Fletcher, C.B.E., LL.B., Dept. SN9, WOLSEY HALL, OXFORD. (Estb. 1894.)

ROYAL COLLEGE OF ADVANCED TECHNOLOGY, SALFORD

Department of Electrical Engineering

Post-H.N.C. — Full-Time Course in Electrical Engineering

A full-time course of about eight months' duration (October-May) is provided by the Department of Electrical Engineering in preparation for the Part III examination of the Institution of Electrical Engineers. This course allows Graduate Membership of the Institution of Electrical Engineers to be obtained in one year as opposed to the two or three years required to cover the syllabus by part-time study.

For entry to the course, students must have passed or be exempt from all subjects of the I.E.E. Part I examination and from the electrical subjects and mathematics of the I.E.E. Part II examination.

Prospective candidates for the course commencing in October, 1964, should apply to the Head of the Department of Electrical Engineering for further particulars.

THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY

CULHAM LABORATORY

SUMMER SCHOOL IN PLASMA PHYSICS

to be held at the Laboratory
6 - 17 July, 1964

Curriculum

A course in basic plasma physics
followed by more specialised courses in :—

Practical applications of plasmas — Astro and geophysical plasmas — Waves in magneto-plasma — Instabilities of confined plasma — Experimental plasma physics — Advance theory of plasma.

Eligibility

Junior researchers and potential research students nearing graduation are invited to apply. Previous knowledge of plasma physics will not be assumed.

CLOSING DATE for applications: 13th April, 1964

No tuition fees will be charged. For further details and Application Forms please send a postcard to the Technical Administration Office, Culham Laboratory, Abingdon, Berkshire.

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